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SIR ISAAC NEWTON'S EARLY STUDY OF THE APOCALYPSE.

By FLORIAN CAJORI.

New facts about great men seldom fail of interest. Newton's eminence as a scientist makes us curious about his speculations in theology. According to biographers, Newton devoted much attention to this subject during the sunset of his life, when his scientifically creative period was largely spent. The present writer is in possession of evidence that Newton busied himself with matters relating to the Revelation of St. John before he published his Principia, the great work upon which his celebrity as an astronomer rests.

Through the courtesy of Julius Wangenheim, a San Diego business man, a collector and student of scientific books, the writer was able to examine marginal annotations in Newton's handwriting, entered upon a book on the Prophet Daniel and the Apocalypse written by the Cambridge Platonist of the seventeenth century, Henry More. Newton's own handwriting on matters of Revelation!

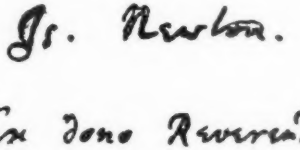


FIG. 1. Newton's handwriting on the fly-leaf of a copy of More's book on Daniel and the Apocalypse.

But before entering upon the annotations, let us endeavor to fix the date when they were written. Both author and annotator lived at Cambridge; More at Christ's College, Newton at Trinity College. More's book was published in 1681; he died in 1687. On the fly-leaf of Wangenheim's copy is written "Is. Newton. Ex dono reverendi authoris" (Is. Newton. A gift of the reverend author.) (See Fig. 1.) Hence Newton was presented with this copy before 1687, most probably right after its appearance from the press. Now, 1687 is also the date of the first edition of Newton's Principia. The manuscript of the Principia was prepared during 1685-1687. Hence it is highly probable that the annotations were made before or during the time when Newton wrote this well known scientific work—during the great creative period of his life. Wangenheim argues, moreover, that Newton's an-

notations are in the hand writing of his "forties," not in that of his old age, that a manuscript letter of Newton of 1682, kept in the British Museum (See Fig. 3), contains the "ye" and other little smirks and mannerisms which are not found in a Newtonian document around 1717. However, an examination of Newton's letters to Cotes and Keill, as printed by Edleston, indicates that Newton used the "ye" even late in life, but not so frequently as he did earlier. If, in addition to these facts, one considers that the printed theological writings of Newton, all of which he prepared late in life, contain no reference to More, then it is clear that a very strong preponderance of cumulative evidence favors an early date for the annotations in More's book.

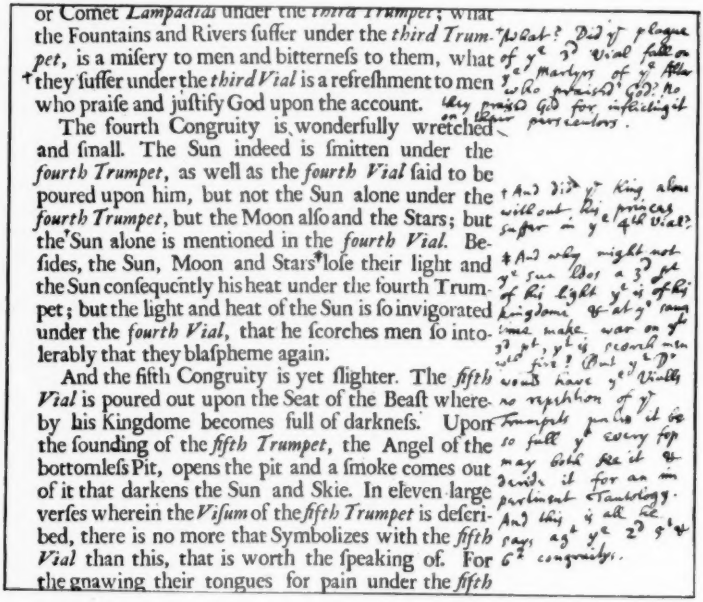
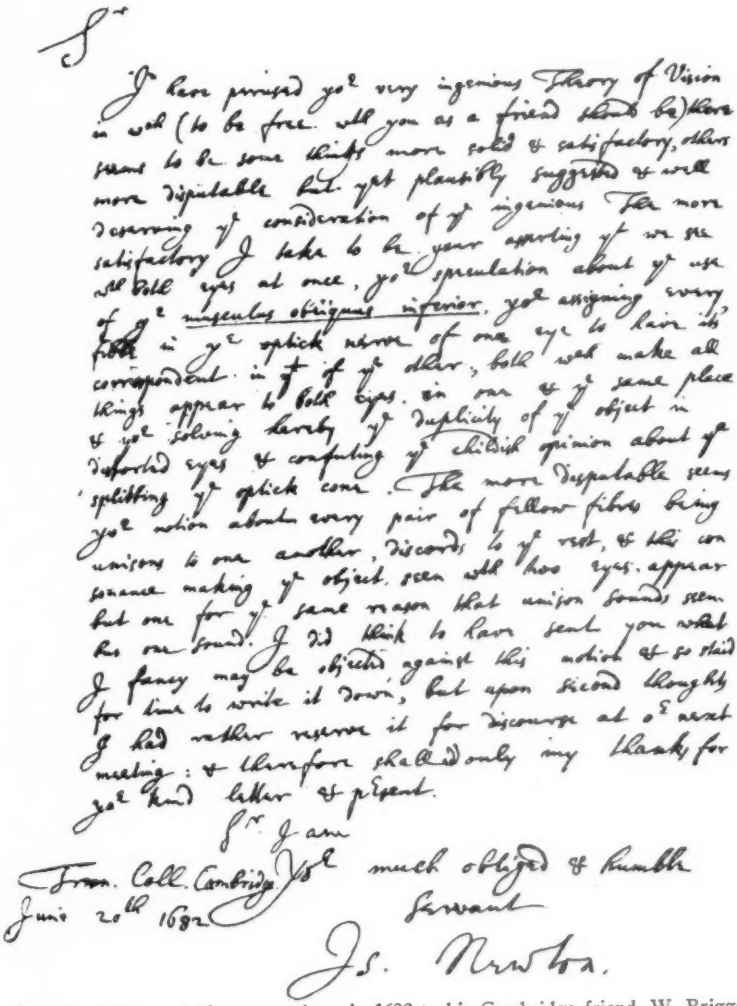

or Comet *Lampadias* under the *third Trumpet*; what
the Fountains and Rivers ſuffer under the *third Trum-*
pet, is a miſery to men and bitterneſs to them, what
†they ſuffer under the *third Vial* is a refreſhment to men
who praiſe and juſtify God upon the account.
The fourth Congruity is wonderfully wretched
and ſmall. The Sun indeed is ſmitten under the
fourth Trumpet, as well as the *fourth Vial* ſaid to be
poured upon him, but not the Sun alone under the
fourth Trumpet, but the Moon alſo and the Stars; but
the Sun alone is mentioned in the *fourth Vial*. Be-
ſides, the Sun, Moon and Stars loſe their light and
the Sun conſequently his heat under the fourth Trum-
pet; but the light and heat of the Sun is ſo invigorated
under the *fourth Vial*, that he ſcorches men ſo into-
lerably that they blaſpheme again.
And the fifth Congruity is yet ſlighter. The *fifth*
Vial is poured out upon the Seat of the Beaſt where-
by his Kingdome becomes full of darkneſs. Upon
the ſounding of the *fifth Trumpet*, the Angel of the
bottomleſs Pit, opens the pit and a ſmoke comes out
of it that darkens the Sun and Skie. In eleven large
verſes wherein the *Viſum* of the *fifth Trumpet* is deſcri-
bed, there is no more that Symbolizes with the *fifth*
Vial than this, that is worth the ſpeaking of. For
the gnawing their tongues for pain under the *fifth*

FIG. 2. Newton's annotations on a page of More's book.

Present day thought disdains apocalyptic prophecy. To a modern scientist, the passing from the Principia to Newton's remarks on Revelation in More's book is indeed descending from the sublime to the ridiculous. It is passing from the brightest pages in scientific thought to what seems puerile and meticulous. To watch Newton's mind focused on these questions is like seeing a powerful telescope capable of revealing secrets of the celestial heights, directed to the inspection of some ghost-like appearance on a near-by roof. But seventeenth century writers took Daniel's prophesies and the Revelation seriously. In one place More says: "I can appeal to God and my

conscience that I have framed no interpretations to serve any interest but that of Truth and the Church or Kingdom of Christ." More argues that in passages in the eighth and sixteenth chapters of Revelation, the



Sr

I have perused yor very ingenious Theory of Vision
in wch (to be free wth you as a friend shall be) there
seems to be some things more solid & satisfactory, others
more disputable but yet plausibly suggested & well
deserving ye consideration of ye ingenious. The more
satisfactory I take to be your assigning ye use
of both eyes at once, yor speculation about ye use
of yr unequal obliquity inferior, yor assigning every
fibre in yr optick nerve of one eye to have its
correspondent in ye of ye other, both will make all
things appear to both eyes. in one & ye same place
& yor solving thereby ye duplicity of ye object in
distorted eyes & confuting ye childish opinion about ye
splitting ye optick cone. The more disputable seems
yor notion about every pair of fellow fibres being
unisons to one another, discords to ye rest, & this con
sonance making ye object seen wth both eyes appear
but one for ye same reason that unison sounds seem
but one sound. I did think to have sent you what
I fancy may be objected against this notion & so staid
for time to write it down, but upon second thoughts
I had rather reserve it for discourse at ye next
meeting: & therefore shall only my thanks for
yor kind letter & present.

Sr I am

From Coll. Cambridge Yor much obliged & humble
June 20th 1682 Servant

Js. Newton.

FIG. 3. A letter of Newton, written in 1682 to his Cambridge friend, W. Briggs.

seven angels who successively sound seven trumpets followed by great plagues were not contemporaneous with the seven angels who from seven vials poured out the wrath of God. More presents nine distinct

arguments in support of his contention. Newton wrote ten annotations in criticism of those arguments. Our facsimile illustration relates to the fourth trumpet and the fourth vial. Under the fourth trumpet the third part of the sun, moon and stars was smitten, while under the fourth vial the sun was given power to scorch men with fire, and nothing is said of the moon and stars. In More's opinion, this diversity is sufficient to mark the two events as distinct. But Newton says (we write Newton's contracted words in full): "And why might not the sun lose a third part of his light that is of his kingdom and at the same time make war on that third part, that is, scorch men with fire? But the Doctor would have the vials no repetition of the trumpets unless it be so full that every fop may both see it and deride it for an impertinent tautology. And this is all he says against the second, fifth and sixth congruities." (See Fig. 2.)

Frankly, most readers would not recognize in this passage the mind of Newton. In the field of pure allegory and unchecked imagination, necessary conclusions cannot usually be drawn; here Newton was as helpless as anyone. The interesting feature which we have presented for the first time is that Newton indulged in the study of weird questions of Revelation much earlier than has been supposed, namely, about the time when he was applying the law of gravitation to planetary and cometary motion, and was writing his Principia.

University of California.

THE ACCURACY OF OPPOLZER'S ECLIPSE MAPS.

By WILLIAM F. RIGGE.

There is a very general misconception of the accuracy of Oppolzer's eclipse maps. This astronomer, as is well known, published in 1885 that immortal work entitled "Canon der Finsternisse," which gives the numerical data for 8000 solar and 5200 lunar eclipses occurring between the years 1207 B. C. and 2161 A. D. The central lines of all the solar eclipses that fall norht of 30° south latitude are plotted on 160 charts. It is these charts that give the book its greatest practical value, because they show in a graphic way and almost at a glance, whether and when and how often a total eclipse is visible in a given locality.

In view of the high reputation that Oppolzer's work enjoys, and that of course most deservedly, it sounds somewhat malevolent to touch the question of its accuracy. To the vast majority of those that make use of the maps, there is never the least suspicion of even the smallest unreliability. They transfer the path of totality of a certain eclipse as given in the book exactly as it is to a greatly enlarged sectional map of that part of the world, just as if Oppolzer's chart was a lantern slide

and was projected on a large wall map. They will then give us the names of all the cities and towns that lie within the belt of totality.

It is well, in parenthesis, to see what this magnification really means. Oppolzer's charts are drawn on a north polar projection. The meridians

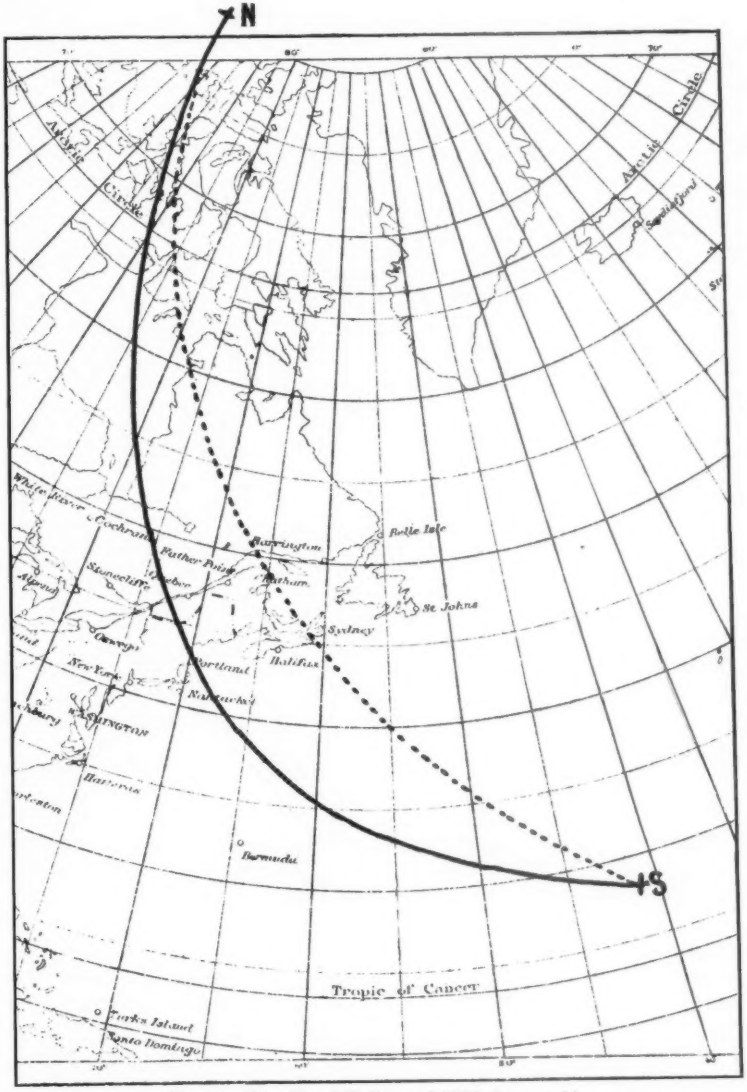


FIG. 1. The Total Eclipse of 1932 August 31.

are (radial) straight lines with 100° equal to 3.34 inches (= 8.48 cm), or 1° or about 70 miles equal to about 1/30 inch, and 10 miles to about 1/200 inch. How, on such a scale, cities and towns may be located is a problem that is left to the reader.

Oppolzer's Eclipse Paths Not Accurate.

Setting aside this exaggerated accuracy that is attributed by many to Oppolzer's charts, and contenting ourselves with the more moderate one that they present to the eye or even through a pocket magnifying glass, it may come as a shock to the general reader to say that the eclipse tracks as given on the charts are reliable only in three points, their sunrise, noon, and sunset points, and that in all other places they

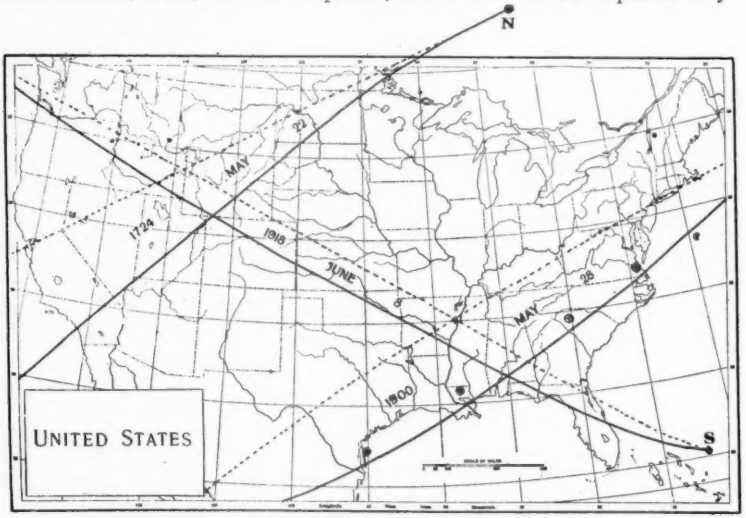


Fig. 2. The Total Eclipses of 1724, 1900, 1918.

may be several degrees in error. They cannot be depended upon to indicate even the State in the Union through which the belt of totality will pass. No one will believe this, or even think it possible that Oppolzer could enjoy the reputation that is given him, while his much-lauded book contains such enormous errors. And yet, the statement is true, and will be supported by all who have worked in this field. But even these had to be forced by the merciless argument of facts before they would admit it.[1]

Figs. 1 and 2 show the extent of the errors in four eclipses. In every case the dotted line is the path of totality as given in the charts; while the full lines for 1900 and 1918 are those taken from the *American Ephemeris,* the one for 1724 has been plotted from Oppolzer's numer-

[1] Popular Astronomy, XXVIII, 323, 1920, June-July.

ical data, and the one for 1932 has been computed by Mr. F. E. Seagrave and published in POPULAR ASTRONOMY last November, XXXIII, 628. The points marked N are the noon points, and the ones marked S the sunset points. In all these cases the dotted paths happen to be north of the others, but this is here purely accidental. The separation of the paths will be seen to amount in some places to over five degrees or over 350 miles. In 1900 the chart path passed through the middle of the states of Texas, Arkansas, Kentucky, West Virginia, and New Jersey, while the true path avoided these states altogether.

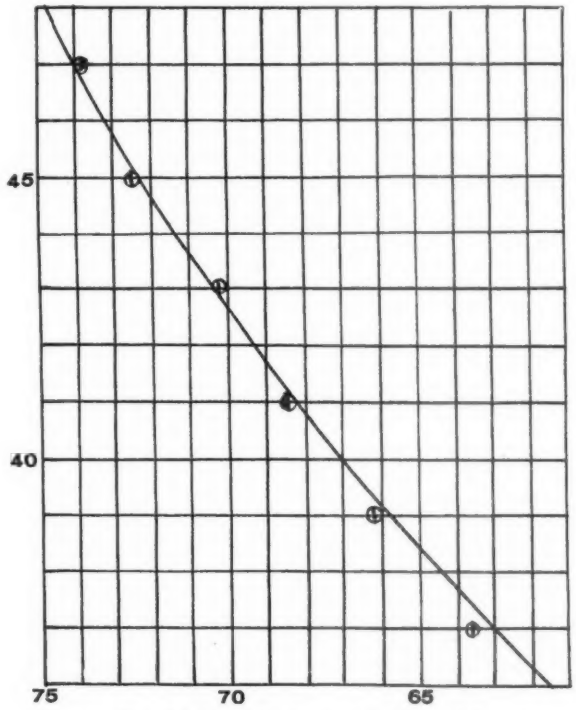


FIG. 3. The Computed Paths of Oppolzer and Seagrave for the Total Eclipse of 1932 August 31.

The four eclipses exemplified are by no means exceptional. On the contrary, such errors will be found to be inherent in every path given in Oppolzer's charts, and that from the very method he used in plotting them. But before we come to this phase of the subject, it is well to see how eclipse paths may be drawn entirely free from such errors, not only from such gross ones, but even from such inaccuracies as would interfere with the proper location of astronomical instruments.

How a Correct Eclipse Track is Drawn.

There is only one method, known as Bessel's, that is used at present for both the numerical and graphical construction of eclipse maps. In this method the observer is supposed to be stationed in the sun and to look down on the rotating earth while the moon with its concentric umbra and penumbra is moving across it. This is equivalent to making an orthographic projection of the earth for the given declination of the sun. In the graphic methods points are then selected on the moon's path at known times, and their latitudes and hour angles estimated, the latter being changed to longitudes by means of the known longitude of the central meridian at the moment. In the numerical way the plane ordinates and abscissae of the selected points are converted by computation into their corresponding latitudes and longitudes.[2]

From the principle of the method thus briefly outlined it will be evident to all, even to those that have only a rudimentary conception of it, that the plotting of a sufficient number of points in the track of totality (or annularity) will require a considerable amount of time, especially when the author realizes that his work is to be authoritative. But when about four thousand of such paths were to be drawn, the vast majority of which would certainly never be used, but of which almost any one might be called upon to testify in an historical case, would not common sense declare such accuracy wasted, and suggest the employment of a more time-saving, even if much inferior, accuracy, such a one however that in any particular case a future computer could find all the essential data and, by doing some work of his own, be able in reality to obtain all the accuracy that the data implicitly contained?

Oppolzer's Method.

No one certainly realized the situation better than Oppolzer himself. We must be thankful to him that he contented himself with an inferior accuracy, and by such a prudent decision made the publication of his work possible.

"The object of the charts," he says on page XXXV of his Introduction, "is to present in a graphic way the principal points of the central lines of eclipses, so that they may direct the computer in his investigations as to whether and which eclipses are of importance for a given place. For this purpose the three principal points of centrality, those namely of centrality at sunrise, at noon, and at sunset were entered upon the charts. In order to find at once these three connected points, they were joined by an arc of a circle . . . . It is evident that this arc of a circle approximates to a certain degree the true curve of centrality, and the more the nearer the part of the arc is to one of the three principal points. The parts of the arc however that are somewhat farther away will probably not be very much in error, so that this error, on

[2] For the necessary details see the book "Graphic Construction of Eclipses and Occultations," which was reviewed in Popular Astronomy on the very last page of its volume for 1924.

account of the small scale used in the charts, will not be so very conspicuous . . . although the parts very far away may often show considerable differences."

From these last words it is plain that it is doing Oppolzer an injustice to expect the eclipse paths given in his maps to be so correctly located in all their parts, that they may be transferred to sectional maps on a much larger scale and then be reliable to a fraction of mile. This is however the general expectation. It is an erroneous one, and was neither his intention in principle nor could it have been so in practice. The writer of these lines has twice[3] already called attention to this fact, and has come to the conclusion that a special article on the subject might emphasize it more strongly.

A word about the mechanical execution of the charts will present another view of the case. Photography was not available in Oppolzer's time. With this it is an easy matter now-a-days to draw the blank map on a large scale, and insert in it in a color which will not show on the photograph, intermediate lines to every degree, by means of which any curve whatever can be accurately plotted. Mistakes can be easily corrected, and letters and numbers and outlines of countries inserted in the ordinary way.

Oppolzer was compelled to use the lithographic method, in which the drawing is made on the flat surface of a stone. When executed directly upon the stone, right and left had to be reversed. Mistakes were hard to rectify, and it is evident why a circle should be preferred to every other curve. When all these circumstances are duly weighed, it is plain that if the "Canon der Finsternisse" was to appear at all, the moderate accuracy adopted by Oppolzer was the only one that could have been employed.

Oppolzer's Numerical Data.

Oppolzer's numerical data were the best in his day. They are not perfect, and at times corrections to them are published. Our present data are of course more accurate than Oppolzer's, but they also will be corrected by the astronomers of the next generation.

From this it by no means follows that Oppolzer's data deserve no credit whatever. On the contrary, if those, who are deterred by the large errors in his eclipse paths, as exemplified in Figs. 1 and 2, will only make use of his numerical data and reconstruct their eclipse paths from them, they will be agreeably surprised to see that for map purposes there is very little difference between the corrected, and really the true, Oppolzer track and the modern one as given in the *American Ephemeris*. Thus in Fig. 2 the small circles with crosses in them, that may be seen near the *Ephemeris* path of the total eclipse of 1900 May 28, would plot a curve that would lie very close to the true one. In Fig. 3 the curve shown is a part of Mr. Seagrave's computed path for the eclipse of 1932 August 31, more magnified than in Fig. 1, and the

[3] Popular Astronomy, XXVIII, 323, and XXXII, 13.

circlets are on Oppolzer's computed track. Here also the difference is very small.

In strict justice it is necessary to add that while Oppolzer's numerical positions in these cases locate the central line of the eclipse with remarkable accuracy, his times however are not so reliable. In the 1932 eclipse his times are about 13 minutes greater. In order to investigate this to some degree, ten recent eclipses were taken. The smallest divergence between Oppolzer and the *American Ephemeris* was found to be 1.3^m, the average of nine was 5.5^m, but one was 13.4^m. The error in 1932 is therefore very probably not accidental. For ancient eclipses, and even for those up to about fifty years ago, these differences both in the times and in the paths are of little, if any, consequence. For future eclipses those that wish to be certainly within the belt of totality, will evidently not use Oppolzer at all, but the best modern data.

SUMMARY.

The accuracy of Oppolzer's eclipse charts is quite generally overrated. The paths are measured with a magnifying glass and transferred to maps of a much larger scale. Such accuracy was neither intended by Oppolzer, nor could it have been employed. Only three points in each path were accurately plotted, the sunrise, noon, and sunset points, and through these an arc of a circle was drawn. The path is thus only very approximate, and may differ five degrees or more from the true one. The method of drawing a correct path is indicated, and it is shown that especially from the large number of the tracks to be drawn, it was necessary for Oppolzer to be content with an inferior accuracy. His numerical data are however very reliable especially for old eclipses; and when a path of a present-day eclipse is drawn from them, the divergence of his path from the modern one is remarkably small.

THE CROSS AND THE CROWN.

There is a cross amid the evening sky,
When summer comes again;
There is a crown which sparkles clear and high
Above the homes of men.

That northern cross is set with Deneb's gem,
With jewels, five in all;
That northern crown shines like a diadem
Of diamonds, bright and small.

There was a Cross, a Cross of agony,
Whereon for us Christ bled;
There was a Crown, a Crown of mockery,
They placed upon Christ's head.

—CHARLES NEVERS HOLMES.

Newton, Mass., 41 Arlington St.

REPORT ON MARS, NO. 33.

By WILLIAM H. PICKERING.

The Martian Survey.

In this Report we shall describe a survey that we have made of the planet in the interval between the years 1913 and 1922 inclusive. At the first opposition recorded, that of 1914, the solar longitude ☉ was 16°.8. At the last opposition it was 171°.3. The solar longitude at the planet's vernal equinox is 0°.0, and at the autumnal 180°.0. At all five oppositions therefore the northern hemisphere was turned toward the sun, and also toward us. At the oppositions of 1924, 1926, and 1928 the southern hemisphere was and will be presented to the sun, and a second survey is proposed which will include them. These two surveys, which will cover the whole surface of the planet, will both be based exclusively on drawings, because this is by far the most rapid and most complete method of studying the surface. Transits have also been taken of special points, and it is hoped to discuss them in a future Report.

In 1924 a brief series of micrometer measures was made by Mr. Hamilton, with the same telescope that was used for the drawings. Latitudes only were determined. In all 30 measurements of 18 different points were secured, each measurement consisting when possible of 12 readings, giving 3 measures from each limb. Eight of the points were observed from two to five times. The average deviation of a single measurement consisting of twelve readings was found to be $\pm 1°.62$. The average deviation of a single measure of these same eight points taken from the drawings was $\pm 2°.49$. Squaring these numbers and dividing, we find that one micrometer measurement is as accurate as the mean of 2.4 drawings. The twelve readings required on the average 14 minutes. The total time required to make eleven very complete, large scale, drawings, fully shaded, in May 1920 was 361 minutes. From them we derived for our survey 64 measures of points near the central meridian. Average time for each point 5.6 minutes. This was exceptional, but a fair average for measures from drawings made near opposition would certainly not exceed 8 minutes. In order to obtain the same accuracy with drawings that we secure with the micrometer requires therefore 1.35 times as long. At the same time we get a shaded and finished picture, to which we can refer at any time in the future for other information, and also if required, in order to measure other points which we had not thought of measuring before. Incidentally the drawings give us also the longitudes, which if measured with the micrometer require as much time as the latitudes, and if measured by transits of the central meridian, about as long. The ad-

vantage for survey work of the method by means of drawings, if one has a reasonably correct eye, over the micrometer method becomes at once obvious.

In order to give a preliminary idea of the accuracy of the work, we may say that the combined probable errors of the latitudes and longitudes of the 10 best known points on Mars, each drawn from 9 to 20 times, averages ±25.1 miles. This is equivalent to ±0.68 of one degree of latitude. Taking the angular diameter of Mars at an average northern apparition as 14″, we have 1″ = 300 miles, so that the probable error of the mean in the location of these 10 points is ±0″.084, a result that compares very favorably with the better measures of double stars made with our larger telescopes. The distance 25.1 miles is 0.59 of one per cent of the diameter of the planet, and is the width of a rather narrow canal. The ten points here referred to in the order of the accuracy with which their positions are determined, the most accurate coming first, are Elysium N., Elysium S., Nepenthes c., Niliacus S., Thymiamata f., Ismenius, Syrtis N., Aromatum p., Neith N. f.,

TABLE I.

MARTIAN LATITUDES AND LONGITUDES.

No.	Station	Diam.	Ephemeris		A	O	Corrected	
		″	°	°			°	°
	CLASS A							
3	Sabaeus f.	15.3	— 5.6±2.8	8.2±1.9	5	5	— 4.9±2.6	8.3±1.8
5	Margaritifer N.	14.6	+15.8±1.2	17.6±2.8	5	10	+16.3±1.7	17.0±3.0
6	Oxia	15.1	+14.6±2.0	18.0±2.8	4	6	+15.2±1.3	17.6±2.8
7	Thymiamata f.	14.7	— 1.3±2.3	19.3±2.8	5	20	— 0.7±2.2	19.3±2.8
8	Aromatum S. p.	14.5	— 1.7±2.4	30.4±2.8	5	15	— 1.0±1.8	30.5±2.8
11	Niliacus S.	13.9	+28.3±2.6	36.8±2.7	5	19	+28.9±2.5	35.9±2.7
18	Lunae c.	11.7	+20.4±2.8	61.6±2.8	4	8	+19.7±2.8	60.9±2.9
23	Maeisia	15.7	—11.6±1.3	72.0±3.1	5	5	—11.5±1.3	72.4±3.1
32	Phoenicis	14.8	—11.7±2.4	106.1±2.2	4	7	—12.0±2.4	106.5±2.4
43	Titanum N.	14.6	—18.4±2.9	165.1±2.6	5	13	—18.0±2.2	165.6±2.4
54	Elysium N.	14.3	+35.3±3.1	212.6±1.9	5	20	+35.6±2.2	211.5±1.9
55	Elysium S.	14.3	+13.4±3.3	212.8±2.0	5	20	+13.6±2.1	212.4±2.0
63	Triton N.	15.0	+19.0±4.0	256.8±2.8	5	10	+19.2±2.8	256.2±2.7
68	Libya S.	14.8	— 8.8±3.5	268.8±1.5	5	10	— 8.6±2.7	269.1±1.4
69	Nepenthes c.	13.7	+10.8±3.1	269.7±1.9	5	20	+10.9±2.6	269.4±2.0
71	Neith N. f.	15.1	+46.3±2.5	279.5±3.2	5	9	+46.2±1.5	277.5±3.0
74	Syrtis N.	13.7	+25.4±3.3	285.7±3.4	5	20	+25.4±2.5	285.0±3.2
75	Meroe S.	15.0	+22.5±1.2	288.0±2.5	4	5	+22.3±1.7	287.2±2.2
87	Sirbonis	13.3	+13.3±2.8	321.6±2.4	3	6	+13.8±3.1	321.2±2.3
91	Ismenius	13.7	+45.7±2.5	331.8±3.4	5	20	+45.9±2.6	330.0±3.6
92	Juturna	14.5	+20.8±4.1	330.6±2.6	3	6	+20.1±2.9	330.0±2.9
96	Furca N. p.	14.3	+ 7.0±2.5	351.2±2.4	5	10	+ 7.2±1.8	351.0±2.4
98	Furca N. f.	13.9	+ 8.6±1.9	359.0±2.6	5	5	+ 9.0±1.2	358.7±2.5
99	Furca S.	14.1	— 8.0±2.9	358.7±2.6	5	5	— 7.7±1.3	358.9±2.6
	CLASS B							
17	Aurorae N.	14.3	— 8.0±3.0	55.0±4.6	5	10	— 7.5±2.9	55.2±4.6
24	Solis N.	15.3	—22.0±1.6	84.1±5.2	5	5	—21.9±1.1	84.7±5.1
46	Aesculapius c.	14.6	+ 0.5±2.0	175.5±2.6	5	5	+ 1.0±1.8	175.5±2.6
50	Laestrygonum N.	15.0	—14.5±2.8	196.5±3.6	5	5	—14.2±1.8	196.9±3.7
58	Cimmerium N.	15.0	— 2.2±1.8	231.9±4.3	5	10	— 2.1±2.2	232.0±4.3
94	Edom S.	13.8	— 2.6±2.7	346.3±3.8	5	15	— 2.4±2.6	346.4±3.8

TABLE I.—Continued.

CLASS C

No.	Station	Diam.	Ephemeris		A	O	Corrected	
		"	°	°			°	°
14	Tempe p.	13.8	+45.9±3.5	48.6±2.9	5	10	+45.9±3.3	46.8±2.7
52	Elysium p.	15.6	+25.8±2.1	201.1±2.2	5	5	+26.0±3.3	200.3±2.0
56	Elysium f.	15.6	+22.9±4.7	225.7±1.6	5	5	+23.3±4.6	225.1±2.0
60	Thoth c.	15.4	+27.6±3.0	251.9±2.3	5	5	+27.6±4.3	251.2±1.8
93	Sigeus N.	15.5	— 4.7±3.3	335.5±0.9	5	5	— 4.2±2.3	335.5±0.9

CLASS D

No.	Station	Diam.	Ephemeris		A	O	Corrected	
		"	°	°			°	°
4	Acidalium p.	14.9	+53.4±2.2	14.0±5.5	5	5	+53.5±3.0	11.8±6.6
12	Acidalium N.	11.7	+63.3±2.0	44.4±9.6	3	9	+64.0±1.2	40.1±8.9
15	Acidalium f.	14.9	+54.6±3.0	54.0±4.8	5	5	+55.3±3.2	52.2±5.5
16	Baltia S. p.	14.5	+60.7±1.6	58.2±7.6	2	4	+60.8±2.8	53.4±7.8
22	Nectar p.	14.8	—25.6±4.8	62.7±4.2	5	10	—25.5±4.0	63.5±4.2
25	Ceraunius p.	15.0	+55.0±3.5	87.4±6.0	5	5	+55.1±2.7	84.8±5.7
26	Solis c.	14.3	—27.0±2.4	86.5±3.7	5	17	—26.2±2.3	87.1±3.8
28	Solis f.	15.3	—28.4±2.9	93.4±4.8	5	5	—28.0±2.7	94.1±5.0
29	Thaumasia S.	13.8	—46.4±3.1	94.4±4.0	3	4	—46.6±2.0	95.0±3.2
34	Arcadia N.	12.9	+51.4±2.7	118.9±4.2	4	7	+52.3±3.0	116.0±4.6
35	Icaria N.	14.8	—38.5±3.5	120.0±2.4	4	6	—38.2±3.4	121.3±2.4
39	Castorius p.	14.2	+50.4±2.9	148.3±2.0	4	5	+50.5±3.0	145.6±2.0
42	Arsenia N.	13.5	+58.8±3.3	163.5±2.6	4	12	+59.7±3.3	160.0±3.1
45	Olympia p.	13.2	+80.8±3.8	187.1±11.5	2	4	+80.3±4.4	172.1±14.8
47	Electris N.	14.1	—41.5±2.8	179.2±2.2	5	9	—40.8±2.1	180.9±2.0
51	Olympia c.	13.0	+78.9±1.2	213.8±4.7	2	4	+78.8±1.5	198.8±5.4
53	Gyndes S.	15.1	+56.9±3.3	209.3±3.8	5	5	+57.3±1.5	207.3±3.9
57	Olympia f.	13.5	+79.2±3.4	240.6±8.1	2	4	+79.7±3.5	225.6±7.7
65	Boreosyrtis N.	13.3	+69.4±2.9	270.7±2.6	3	5	+70.4±3.9	264.0±2.7
66	Achates S.	11.7	—38.4±7.2	264.9±1.1	2	4	—38.3±4.5	264.8±1.8
77	Hellas N.	13.8	—29.5±3.9	291.2±4.8	5	5	—29.2±3.7	292.2±5.0
78	Boreosyrtis N. f.	13.1	+67.0±1.3	299.7±7.1	2	4	+67.6±1.6	293.4±7.2
89	Arethusa	14.4	+62.2±1.0	331.2±3.2	2	4	+61.8±0.8	326.4±2.5

CLASS E

No.	Station	Diam.	Ephemeris		A	O	Corrected	
		"	°	°			°	°
2	Pandora f.	14.6	—23.0±2.8	7.1±4.6	3	4	—23.0±4.3	7.8±4.4
9	Acidalium S.	13.3	+41.1±3.3	32.2±3.0	5	20	+41.3±3.7	30.9±3.2
19	Lunae S.	15.0	+11.7±4.0	61.9±3.4	5	5	+12.4±4.9	61.6±3.4
31	Croesus	9.8	+27.6±2.3	106.0±2.3	4	4	+29.0±2.4	104.8±2.6
40	Castorius S.	13.9	+37.6±3.0	156.7±5.0	4	10	+38.7±3.6	155.1±5.2
41	Castorius c.	15.7	+36.6±1.2	157.6±4.2	3	4	+35.6±0.8	155.6±4.1
48	Propontis S.	14.6	+38.6±4.0	183.1±4.1	5	5	+39.1±3.5	181.7±4.3
49	Propontis c.	16.0	+42.8±2.2	185.7±3.5	3	4	+41.6±1.4	183.7±3.3
59	Utopia f.	15.6	+49.0±5.2	248.8±3.6	5	5	+49.6±4.7	247.4±4.3
61	Nuba S	13.6	+27.6±3.0	252.5±4.1	3	5	+29.5±3.0	251.6±4.0
62	Syrtis minor N.	13.9	0.0±2.6	254.6±7.0	5	8	+ 0.1±3.4	254.6±7.0
64	Euxinus S. p. M.	13.5	—17.4±3.8	262.2±10.0	2	3	—16.4±3.6	263.0±10.0
67	Euxinus N. p. M.	13.7	+ 8.1±4.5	268.2±5.4	3	6	+ 9.7±4.0	268.0±5.3
70	Vulturnus N.	10.9	—24.0±1.6	277.5±2.7	2	4	—24.0±1.8	277.4±3.3
72	Euxinus p. m.	12.7	+ 9.7±3.1	280.6±3.2	5	10	+ 9.6±2.9	280.3±3.2
73	Libya f.	13.9	— 2.2±4.1	282.3±3.6	5	5	— 2.2±2.8	282.4±3.6
76	Euxinus S. m.	12.4	+ 3.2±5.5	289.1±4.2	5	10	+ 3.7±5.8	289.0±4.2
79	Euxinus S. f.	15.1	+ 4.4±3.8	295.2±3.9	5	5	+ 4.7±2.3	295.1±3.9
80	Euxinus S. M.	13.7	—14.1±3.5	294.9±5.3	4	8	—12.9±4.5	295.3±5.5
83	Boreosyrtis S. f.	13.7	+47.2±3.4	299.2±3.8	5	9	+48.0±4.6	297.3±3.2
86	Hammonis S.	13 3	—10.5±2.7	319.2±3.8	5	15	—10.2±3.0	319.5±3.8
95	Edom f.	13.7	+ 0.1±3.4	350.3±4.0	5	15	+ 0.3±3.0	350.3±4.0
100	Siloe	14.8	+37.5±2.2	1.3±0.9	4	4	+37.5±2.8	359.7±1.2

TABLE I.—Continued.

CLASS F

No.	Station	Diam.	Ephemeris		A	O	Corrected	
		"	°	°			°	°
1	Pandora S.	14.9	—37.6±2.0	1.8±1.7	1	2	—34.7±1.9	1.8±1.2
10	Horarum S.	14.1	—27.9±1.6	31.7±1.0	2	3	—26.5±1.9	32.7±0.9
13	Nia N.	15.0	—36.2±2.2	45.5±0.9	1	2	—33.8±2.0	46.6±0.7
20	Juventae N.	17.8	+ 6.1±1.4	62.7±3.3	2	3	+ 4.7±0.9	62.6±3.2
21	Juventae S.	15.6	— 4.9±1.6	62.5±3.3	2	3	— 5.0±0.7	62.7±3.4
27	Ascuris	9.4	+43.9±0.8	94.4±1.9	1	2	+44.2±0.6	91.8±1.8
30	Mandevia	14.0	+36.3±2.9	102.3±3.7	3	3	+36.9±0.6	101.3±4.2
33	Thaumasia f. m.	15.0	—38.6±0.4	106.5±2.7	1	2	—35.8±0.4	106.5±2.7
36	Biblis	14.6	+ 4.5±4.0	124.5±3.6	3	3	+ 2.9±4.7	124.4±3.6
37	Thaumasia f. M.	20.4	—30.1±1.4	123.8±5.0	1	2	—32.8±1.2	124.6±5.2
38	Bandusia	13.5	+21.2±3.8	138.8±4.7	2	2	+19.4±3.3	138.0±4.9
44	Moreh	15.8	+20.4±1.6	172.0±2.7	3	3	+19.5±2.0	171.1±2.9
81	Coloe	14.2	+31.0±1.6	297.6±0.6	3	3	+30.5±1.8	296.7±0.7
82	Pseboas	10.8	+47.8±1.4	299.7±7.5	2	2	+46.2±1.6	297.1±7.6
84	Bonis	8.3	+19.8±2.6	306.4±2.3	1	2	+19.2±3.1	305.4±2.2
85	Hellespontus N.	14.4	—30.8±3.0	313.1±2.6	2	3	—33.3±2.4	313.5±3.0
88	Noachis p.	16.8	—38.2±1.2	322.7±2.7	1	2	—41.1±1.1	323.2±3.0
90	Pandora p.	18.1	—26.5±1.7	326.2±2.3	2	3	—28.7±1.2	327.0±2.2
97	Aryn S.	17.8	+ 5.4±2.4	357.2±2.9	1	3	+ 2.6±2.4	357.1±2.9

and Titanum N. The added letters have the usual meanings, N and S for north and south, p and f for preceding and following, and c for center or middle. It may be remarked here that certain points in the table really have smaller probable errors than some of these ten, but were eliminated from consideration because we believed the small values in their cases were due to accident. No point in the table has been measured on more than 20 drawings, made on as many different nights, and none was included unless it had been measured on at least two. Nine of these latter are found, and these are presumably the least accurate determinations that we have made. Their average probable error in latitude and longitude combined is ±105 miles, ±2°.8, or ±0″.35.

The whole investigation involved 712 measurements in latitude, and the same number in longitude, of 224 drawings, of 100 points on the surface of the planet. The results are shortly to be published in full in the Harvard Annals, **82**, but in the meantime a summary of them has been prepared, and is given in Table I. The first column gives the number of the station, by means of which it can be found upon a map which will accompany our next Report. These numbers are given in the order of the longitudes of the stations as recorded in the last column. In the second column, following the name, the letters M and m signify, when used, the maximum and minimum extent of a formation which is subject to change of size. It is a rather singular circumstance that the most conspicuous marking on the planet, the large dark gray, or sometimes bright blue area, which is located at the northern end of the Syrtis, and is usually sharply defined at the south, as well as at the north, has never received a name. As we shall have frequent occasion in this and subsequent Reports to refer to it, I have decided

to call it Euxinus, a name which seems appropriate, since many of Schiaparelli's markings have reference to the countries and rivers in the immediate vicinity of that sea. The third column gives the mean diameter of the planet, taken from the Ephemeris, on the nights when the several drawings of the station were made.

The fourth and fifth columns give the latitude and longitude of the stations computed from the Ephemeris, $\pm$ the average deviation of the single measurements from their mean. This quantity, the deviation, it is believed will be more satisfactory in this place than the probable error of the mean of the series of measures, which will be given for the best known stations with the detailed table in the Annals. A comparison of the average deviations of the different stations among themselves is thus rendered possible. It is not as widely known as it should be to the intelligent reading public that the term "average deviation" is ambiguous, meaning two distinctly different things. To most persons it means the average of a series of deviations from the mean value of a quantity, in other words the mean of the residuals, and may be expressed as

$$\Sigma\, d/n.$$

In that sense it is used in this paper. But to the mathematician it means the average deviation from the unknown true value of the quantity, in other words the computed deviation, and is expressed as

$$\Sigma\, d/\sqrt{n\,(n-1)}.$$

With this meaning of the expression, the formula is analogous to that for probable error.

The next two columns give the number of apparitions in which the point was drawn and measured, and the total number of drawings of it which were measured. Every point has been measured at every apparition possible, and an equal distribution among the apparitions has always been secured unless the point was only occasionally seen at some of them. In following out this rule it has been found necessary sometimes to reject many excellent drawings in certain apparitions in favor of the same number of less satisfactory ones in others. While this has doubtless diminished the accuracy of the result for these particular apparitions, and increased the probable errors over what would have been obtained had all the measures been confined to a single apparition, yet it has been done in order to definitely decide as far as is at present possible as to which points move over the surface, and which ones are stationary. Incidentally it also enables us to determine more satisfactorily the increase in accuracy secured by making use of the Corrected position of the planet's axis, as compared with the position given by the Ephemeris. The latitudes and longitudes using this Corrected position are given in the last two columns. The method of making these corrections is given in full, together with the curves employed, in Report No. **28**. In correcting the longitudes the mean latitude rather than the individual ones has been used.

On comparing the various average deviations in latitude between the fourth and eighth columns, it will be seen that those in the latter column are sometimes larger and sometimes smaller than those in the former. If we consider only the best determined latitudes, however, the thirty contained in classes A and B, we shall find that in only five cases are the average deviations larger in the latter column, in three cases there is no difference, while in 22 cases the latter column gives an improved result, and in many cases this is quite marked. Similar but less marked results are obtained by comparing the deviations in the longitudes given in the fifth and last columns. This matter will be further discussed presently in our description of Table II.

Among the 100 objects observed, 50 have been recorded at each of the five apparitions, and in 43 of these an equal number of measures at each apparition has been made. When 20 measures of a point have been secured it indicates that it was conspicuous at each apparition, and more measures could have been made of it had it been thought necessary. When 15 were made, it implies that not over three good drawings were secured at one or more of the five apparitions. When only 10 or 5 measures were recorded it does not necessarily mean that more could not have been obtained, but in many cases, merely that that number was considered sufficient for our purpose. No object was measured more than once on any one night. That an object was not recorded at an apparition does not necessarily mean that it was not seen. It may have been seen, but our weather may have been such that it was never drawn when near the central meridian of the planet, which is the only place where it can be satisfactorily measured.

Taking up the table now in more detail, we find that the 100 points have been divided into six classes according to their character, latitude, and the assumed accuracy of the measures. Class A consists of 24 points, which are believed to be stationary, or nearly so, and whose positions are accordingly accurately known. No point is admitted to this class which has not been observed on at least 5 different nights. Although two of them were visible at only 3 apparitions, since they were measured at every apparition when they were visible, this seems to offer no reason for excluding them. The three largest average deviations in longitude in the last column are for Maeisia, Syrtis N., and Ismenius. Correcting them for their latitudes, it is found that in each case the linear deviation is less than 3°.0 measured in latitude. The largest deviation in this class is therefore for the latitude of Sirbonis, and amounts to ±3°.28.

Class B consists of curves of long radius which lie in an east and west direction, such for instance as the boundary lines of Solis N. and Edom S., and also of points which like Aurorae N. and Cimmerium N. appear to travel back and forth in an east and west direction, 6 in all. We hope to deal with some of these travelling points in a future paper. No average deviation in latitude exceeds ±2°.9. The deviations in longitude are more or less meaningless, but some of them are of con-

siderable size. Class C consists of curves lying in a meridional direction. Their deviations in latitude mean but little, but the deviations in longitude in no case exceed ±2°.7. Sigeus apparently sometimes shifts in latitude and is therefore put in this class, although a consideration of its deviations alone would justify us in placing it in Class A. No points are admitted into either of these classes which were observed on less than 5 nights. They have all been drawn at every apparition.

All of the points included in classes A, B, and C lie between latitudes +50° and —25°. The limit to the north is set by the fact that some of the points in these high latitudes move about through a limited range in both latitude and longitude, while others, at times covered by the polar cap, were seen at only 2 or 3 apparitions. The limit to the south is set by the winter clouds, which often cover these extreme southern regions. Class D consists of all the well observed points, 23 in number, whose latitudes north and south exceed these limits. Among the points visible at only two apparitions several occur which might have been measured more frequently during those years, but were so clearly defined, or were so obviously changeable, that it did not seem worth while to do so. It is evident that the large average deviations recorded in longitude would be equivalent in actual distance to a much smaller number of degrees measured in latitude, or in longitude at the equator. Excepting for their high latitudes, several of these points such as Electris and Gyndes might have been admitted into the first three classes. The largest deviation of all, Olympia p. ±14°.8 is equivalent in miles to only ±2°.4 measured in latitude. While three or four of these points, like Arethusa, have very small average deviations and probable errors, they are not any of them considered as suitable for points of reference. Class E consists of 23 points, most of which are believed to shift about within certain limits over the surface of the planet. We do not consider that any of them would serve as satisfactory points of reference, although the four lakes Croesus, Castorius c., Propontis c., and Siloe are probably stationary. No point is admitted into either class D or E, with one exception, which has not been measured at least 4 times. The exception is Euxinus S. p. m. in class E, which was observed three times. It was included because this branch of the Euxinus rarely forms, but was measured every time it was detected. Being large and conspicuous it was well observed, and it was thought best to include it with the five other stations connected with this marking.

The 19 points in class F have all been insufficiently observed. The more southern ones were only seen at one or two apparitions. All the others except Aryn are lakes. In December of 1913 Pandora did not reach Horarum sinus just to the south of Margaritifer, as is often the case, but stopped short of it, and sent out a branch to the south. It was through this branch that the so-called flood came down to the Euxinus from the south pole at the time of the melting of the polar cap in 1892, and which is described and illustrated in Report No. 4 (POPULAR AS-

TRONOMY, 1914, **22**, 231). This phenomenon has never been seen since that year. The branch is entered as Pandora S under F. The small dark areas Solis, Lunae, and Niliacus are not considered to be true lakes in this paper. Of the 20 that we have measured, 6 are included in class A, one in class D, 4 in E, and the remaining 9 in class F, which thus becomes the class of lakes. Only 3 of them, Juventae S., Maeisia, and Phoenix, are located in the southern hemisphere. Including these three, 7 were seen at the apparition of 1914, 9 in 1916, 17 in 1918, 12 in 1920, and 15 when the planet was nearer, in 1922. Like the canals they are most numerous in the summer season of the planet.

It must be mentioned here that even when a lake is entered in the table, it does not necessarily mean that it was seen as a dark spot or area. When a lake occurs at the junction of two well known canals, and these canals are clearly visible, the location of the junction has been measured even if the lake was not seen as such. We considered that an accurate determination of the location was of more importance than the mere question of visibility. The lakes are usually small black points, but occasionally they appear as large fuzzy objects, something like Lunae, but smaller. This does not depend on the seeing. If the seeing is poor the lakes are not seen at all. Most of them are seldom visible, but when they are seen, they sometimes come out very clearly. Thus Ascuris was once recorded when the diameter of the planet was only 7″.4, Sirbonis was drawn at 7″.9 and Croesus when the planetary diameter was 6″.7, and again 7″.8. Neither of these lakes was often seen, especially Ascuris. Excepting for these three lakes no measures of planetary detail were made when the diameter was less than 8″, and comparatively few when less than 10″, as may be judged by the third column of the table. While Ismenius, the most completely observed lake, does show a steady tendency to move southerly about 3° from the first to the last apparition, and a not wholly continuous tendency to increase its longitude by 6° during the same interval, yet its motion if real is hardly sufficient to take it out of class A, and the evidence is pretty strong that the lakes as a whole are practically stationary. Only two out of the twenty, Biblis and Bandusia, show evidence of motion by their large average deviations. When so few drawings occur however, the size of the deviation is more probably explained by supposing either that one of the drawings was a poor one, or that two different lakes were observed at the two apparitions. Therefore excluding Ismenius, which may possibly be analogous to Solis and Lunae, we may lay it down as an acquired fact that the lakes for all practical purposes are stationary points on the planet's surface.

On a map for the sake of clearness, and in tables for sake of brevity, it is always desirable to avoid all unnecessary lettering or printing. The generic terms such as Lacus, Sinus, Fastigium, etc., have, therefore, all been omitted. As in our previous reports, it has not been thought desirable to change the well known names such as Aurorae, Lunae, etc., from the genitive to the nominative case by dropping the e, and our

readers may therefore imagine Sinus, Lacus, etc., added where necessary to meet the requirements of Latin construction. In identifying the lakes, if our position agrees within 5° or 10° with that of some previous authority, his name for the lake has been used. If it does not agree with any previously named lake we have named it. There are two Juventaes differing in latitude by about 10°. They have appeared alternately in different apparitions, Juventae S. in 1914 and 1920, Juventae N. in 1916 and 1922, but they have never been seen at the same time. The position of Juventae on our standard map lies halfway between them, and agrees with that given by Schiaparelli on his first map showing this marking, that of 1882. There is also a third Juventae much smaller than the others, and seen for the first time in 1924. It lies 5° or 10° to the east of the southern one.

Position of the Axis of Mars.

It has been thought desirable to give the latitudes and longitudes in Table I both according to the Ephemeris, and according to the Corrected position of the axis of Mars, in order that those who prefer the for-

TABLE II.

Deviations Obtained with the Ephemeris and Corrected Poles.

			Classes A and B combined. Latitudes.									
			1914		1922		'14—'22		1918		'18—M	
No.	Station	Obs.	E	C	E	C	E	C	E	C	E	C
			°	°	°	°	°	°	°	°	°	°
3	Sabaeus f.	3	— 9.5	— 6.6	— 2.4	— 5.0	— 7.1	—1.6	— 3.3	— 2.0	+2.7	+3.8
5	Margaritifer N.	6	+13.2	+15.9	+15.8	+13.3	— 2.6	+2.6	+16.7	+17.4	+2.2	+2.8
7	Thymiamata f.*	12	— 2.0	+ 0.8	+ 1.6	— 1.0	— 3.6	+1.8	— 2.1	— 0.9	—1.9	—0.8
8	Aromatum S. p.*	9	— 3.7	— 1.0	+ 2.6	— 0.1	— 6.3	—0.9	— 1.7	— 0.9	—1.1	—0.3
11	Niliacus S.*	12	+28.8	+31.6	+31.4	+28.9	— 2.6	+2.7	+28.4	+29.2	—1.7	—1.0
23	Maeisia	3	—14.8	—11.9	—10.7	—13.1	— 4.1	+1.2	—11.5	—11.7	+1.3	+0.8
32	Phoenicis	3	—14.3	—11.5	—11.8	—14.4	— 2.5	+2.9	....	....	...	...
43	Titanum N.*	9	—19.8	—16.9	—13.9	—16.7	— 5.9	—0.2	—18.6	—18.2	—1.8	—1.4
54	Elysium N.*	12	+33.3	+36.0	+39.4	+36.6	— 6.1	—0.6	+34.0	+34.5	—2.4	—1.8
55	Elysium S.*	12	+ 8.7	+11.5	+17.2	+14.4	— 8.5	—2.9	+12.5	+13.0	—0.5	0.0
63	Triton N.	6	+16.0	+18.9	+27.8	+24.9	—11.8	—6.0	+19.4	+19.5	—2.5	—2.4
68	Libya S.	6	—15.1	—12.3	— 3.0	— 5.8	—12.1	—6.5	— 7.5	— 7.2	+1.5	+1.8
69	Nepenthes c.*	12	+ 5.9	+ 8.8	+13.7	+10.9	— 7.8	—2.1	+13.4	+13.6	+3.6	+3.8
71	Neith N. f.	5	+42.8	+45.7	+49.3	+46.6	— 6.5	—0.9	+46.4	+46.4	+0.4	+0.2
74	Syrtis N.*	12	+22.0	+24.8	+28.8	+26.0	— 6.8	—1.2	+25.4	+25.4	0.0	0.0
87	Sirbonis	6	+14.6	+17.4	+18.9	+16.1	— 4.3	+1.3	+10.5	+10.8	—6.3	—6.0
91	Ismenius*	12	+45.9	+48.6	+47.8	+45.1	— 1.9	+3.5	+45.2	+45.6	—1.6	—1.2
92	Juturna	6	+17.5	+20.4	+24.9	+22.1	— 7.4	—1.7	+16.2	+16.8	—5.0	—4.4
96	Furca N. p.	6	+ 4.7	+ 7.5	+10.7	+ 7.8	— 6.0	—0.3	+ 6.2	+ 6.6	—1.5	—1.0
98	Furca N. f.	3	+ 5.5	+ 8.4	+11.1	+ 8.3	— 5.6	+0.1	+ 6.9	+ 8.0	—1.4	—0.4
99	Furca S.	3	—12.4	— 9.5	— 5.7	— 8.6	— 6.7	—0.9	— 8.1	— 7.3	+0.9	+1.7
17	Aurorae N.	6	—10.4	— 7.7	— 2.4	— 5.2	— 8.0	—2.5	— 7.4	— 6.0	—1.0	+0.4
24	Solis N.	3	—22 9	—20.0	—18.6	—21.5	— 4.3	+1.5	—21.6	—21.5	—0.8	—0.7
46	Aesculapius c.	3	+ 2.3	+ 5.2	+ 3.8	+ 0.9	— 1.5	+4.3	— 3.1	— 2.0	—6.1	—5.0
50	Laestrygonum N.	3	—19.5	—16.8	—13.1	—16.0	— 6.4	—0.8	—13.8	—12.8	+2.5	+3.6
58	Cimmerium N.	6	— 1.7	+ 1.2	— 0.3	— 3.1	— 1.4	+4.3	— 2.8	— 2.5	—1.8	—1.5
94	Edom S.*	9	— 5.2	— 2.4	— 0.7	— 3.4	— 4.5	+1.0	— 2.7	— 2.5	+0.3	+0.4
	Means						—5°.64	—0°.07			—0°.85	—0°.33

*One of the 13 original stations.

mer, or find them more convenient for their special investigations may have them for that purpose. The method of reducing the measures from one axis to the other has, as already stated, been fully described in Report No. **28**. Except in the polar regions, where it is of small consequence, the correction has but little effect on the longitudes. A glance at the average deviations in latitude will however quickly show that those in the column headed Ephemeris are larger than those in the column under Corrected. The mean of the values for class A are Ephemeris ±2°.64, Corrected ±2°.16. In class B we have Ephemeris ±2°.32, Corrected ±2°.07. The differences in favor of the corrected values are small, because these columns contain drawings made during five different apparitions, and at some of these apparitions the correction was insignificant. If we consider however merely those years at which the correction would be at its maximum, the apparitions of 1914 and 1922, when the planet was at its two equinoxes, the difference becomes more marked.

In Table II Classes A and B are combined. These are the only stations whose latitudes are accurately known. Out of the 30 stations comprising these two classes, only the 27 which were drawn in both 1914 and 1922 are included in this table. The third column gives the total number of observations for each station at the three apparitions of 1914, 1918, and 1922. The total number of all the observations considered is 188. The fourth and fifth columns give their latitudes as determined in 1914, using the Ephemeris and Corrected axes of the planet. The sixth and seventh columns give their latitudes as determined in 1922. These latitudes should of course be identical with those determined in 1914, since all of these stations are believed to be stationary on the planet. The eighth and ninth columns give the difference between the determinations in 1914 and those in 1922 for the two axes. Summing them up at the bottom of these columns, we find that if we adopt the axis of the Ephemeris, these points will in that interval every one of them have moved northerly an average distance of 5°.64, or a trifle over 200 miles measured on the surface of the planet. The least northerly motion of any of them, that of Cimmerium, was 50 miles. According to the Corrected position of the axis, the mean motion northerly was 0°.07 or a trifle less than three miles. Three miles for an average motion of nearly thirty points is however three miles too much, and we shall presently proceed to correct it. The correction to the axis should of course be only one half of 5°.64, or 2°.82, but this of necessity is rather too small, since all the drawings were not made in those portions of the orbit where the error is most marked. The original 13 stations employed in Report No. **26** gave us an error of 2°.95. Although it is true that 10 of these stations, those marked with an asterisk, are included in the present investigation, yet we see that there are 17 other stations which agree in yielding practically the same result. It might be suggested that we should have weighted these 27 stations in proportion to the square roots of the number of observa-

tions of each. This has not been done in this place however, since all those stations having more than 8 observations, whose importance would thus be emphasized, were the very ones used in the first place to locate the Corrected axis. The correction —2°.82 gives us approximately the angular error of the Ephemeris axis in azimuth,—that is in a direction at right angles to the angular error in inclination. This latter error we shall now proceed to investigate.

In the tenth and eleventh columns of the table are given the latitudes of 26 of these points as determined in 1918. Phoenicis was not detected at all that year. Subtracting the mean of the two values in 1914 and 1922 from the value in 1918 gives us in the last two columns the errors in the Ephemeris, and in the Corrected positions of the axis. In our first determination of the inclination in Report No. **26**, we concluded that the error was only —0°.256. Subsequently we decided that this value was probably too small, and in the construction of the curves used in this research called it —0°.4. Later, in Report No. **28**, after a considerable amount of computation had already been done, it was concluded that the error was probably nearer —0°.82, but that it was not sufficiently assured to make a recomputation of the location of the stations necessary. The present result leads us to believe that it is numerically a little over —0°.6.

Having now reached the desirable position of having discovered 26 points and lines on the surface of the planet whose latitudes appear to have remained constant during 5 apparitions, we will proceed to make use of them to secure still more accurate determinations of the values of the constants C and D used in locating the axis. In Table III the first three columns are identical with those in Table II excepting that Phoenicis is omitted. The fourth column is taken from the ninth of Table II, since the value of C, —2°.9, is near enough for our present purpose. The fifth column is computed like the last of Table II, except that D is now assumed to be —0°.6. Weights have been assigned to the stations in proportion directly to the square root of the number of times that they have been drawn. These weights are given in the sixth column. The last two columns give their effect on the corrections to C and D. The first must be divided by 2. Applying these corrections to the assumed values we obtain the new and final values $\mathbf{C = -3°.00}$ $\mathbf{D = -0°.78}$. The results obtained from these 26 stations are almost identical with those obtained from the original 13, as given in Table II of Report No. **28**, —3°.02 and —0°.79. A deviation of 0°.01 measured on the surface of Mars is equivalent to a distance of 2000 feet.

The question may now be asked had we used these Revised constants in the computation of Table I, instead of the preliminary Corrected ones $C = 2°.9$, and $D = 0°.4$, what differences would have occurred in our results? By actual trial we find that while in many cases there will be no change, in no case would the difference between the computed latitudes exceed 0°.3, or 11 miles. The latitudes of all points are shifted slightly towards the north at the time of the summer sol-

stice, and with the Revised constants they would stay there at all seasons. Regarding the longitudes, there is no change until we have passed latitude 20°. In higher latitudes the difference increases at first slowly, but later more rapidly, until by the time we reach 60° the difference in extreme cases may amount to 0°.65.

We have illustrated here a very practical case of wishing to determine the latitudes and longitudes of a considerable number of points on Mars, in this instance 26, by means of a survey, made we have assumed only at the three apparitions of 1914, 1918, and 1922. The points here considered are those contained in classes A and B. The

TABLE III.

DETERMINATION OF THE CONSTANTS *C* AND *D*.

No.	Station	Obs.	$2\Delta C$	ΔD	Wts.	M	N
			°	°		°	°
3	Sabaeus f.	3	—1.6	+4.0	1.7	— 2.7	+ 6.8
5	Margaritifer N.	6	+2.6	+3.0	2.4	+ 6.2	+ 7.2
7	Thymiamata f.	12	+1.8	—0.6	3.5	+ 6.3	— 2.1
8	Aromatum S. p.	9	—0.9	—0.1	3.0	— 2.7	— 0.3
11	Niliacus S.	12	+2.7	—0.8	3.5	+ 9.4	— 2.8
23	Maeisia	3	+1.2	+1.0	1.7	+ 2.0	+ 1.7
43	Titanum N.	9	—0.2	—1.2	3.0	— 0.6	— 3.6
54	Elysium N.	12	—0.6	—1.6	3.5	— 2.1	— 5.6
55	Elysium S.	12	—2.9	+0.2	3.5	—10.2	+ 0.7
63	Triton N.	6	—6.0	—2.2	2.4	—14.4	— 5.3
68	Libya S.	6	—6.5	+2.0	2.4	—15.6	+ 4.8
69	Nepenthes c.	12	—2.1	+4.0	3.5	— 7.4	+14.0
71	Neith N. f.	5	—0.9	+0.4	2.2	— 2.0	+ 0.9
74	Syrtis N.	12	—1.2	+0.2	3.5	— 4.2	+ 0.7
87	Sirbonis	6	+1.3	—5.8	2.4	+ 3.1	—13.9
91	Ismenius	12	+3.5	—1.0	3.5	+12.2	— 3.5
92	Juturna	6	—1.7	—4.2	2.4	— 4.1	—10.1
96	Furca N. p.	6	—0.3	—0.8	2.4	— 0.7	— 1.9
98	Furca N. f.	3	+0.1	—0.2	1.7	+ 0.2	— 0.3
99	Furca S.	3	—0.9	+1.9	1.7	— 1.5	+ 3.2
17	Aurorae N.	6	—2.5	+0.6	2.4	— 6.0	+ 1.4
24	Solis N.	3	+1.5	—0.5	1.7	+ 2.6	— 0.8
46	Aesculapius c.	3	+4.3	—4.8	1.7	+ 7.3	— 8.2
50	Laestrygonum N.	3	—0.8	+3.8	1.7	— 1.4	+ 6.5
58	Cimmerium N.	6	+4.3	—1.3	2.4	+10.3	— 3.1
94	Edom S.	9	+1.0	+0.6	3.0	+ 3.0	+ 1.8
	Mean					—0°.19	—0°.18

position of the axis of Mars has been determined by earlier astronomers for this very purpose, in order to locate accurately points on the surface of the planet. I do not really know of any other reason why we should care to locate the axis. We have determined the errors in its position as given in the Ephemeris by what is certainly the best method, in Reports **26-28**, and the present article; and also in Report **32** by the older method of observing the polar caps, as practiced by Schiaparelli, Lowell and others. Both methods lead to the same result,—that the position of the axis given in the Ephemeris is in error,—and by a very considerable amount. We trust that the Washington authorities will see their way before long to spend the necessary money to correct this serious defect.

The inclination of the planet's axis to the pole of its orbit now becomes **24° 56′**, lying about midway between Struve's value 25° 13′, obtained from the motion of the orbits of the satellites, and those of Schiaparelli and Cerulli, 24° 42′ and 24° 45′ respectively. Lohse's and Lowell's values 23° 57′ and 23° 16′ appear to be hopelessly at variance with the others. The location of the northern pole in the heavens on April 1, 1918, was in α **315° 07′** δ **+51° 49′**. The most marked change produced by the use of the new Revised constants will be to shift the vernal equinox back 7°.16, from heliocentric longitude 87°.89 to 80°.73, equivalent to 14 days, and to increase the solar longitude ☉ of the Ephemeris by this same amount. The Martian dates of the equinoxes and solstices now become, vernal February 43, summer June 11, autumnal September 23, and winter December 1.

We have attempted to locate the axis of the planet by means of the deviations in longitude, at different apparitions, of points in high latitudes. Although perfectly possible theoretically, it is not a practicable method. Even out of the 100 points that we have measured, those in high latitudes, Class D, number only 23. But only 12 of these were visible both in 1914 and 1922, and only 10 if we include also 1918. The others were hidden at times either by the northern polar cap, or by the southern clouds. Of these 10, only 6 points are believed to be stationary. These are Solis c., Icaria N. and Electris N. in the southern hemisphere, and Acidalium f., Ceraunius p., and Gyndes S. in the northern, with which to compare them. Indeed it is by no means certain that all of these points, particularly the last one, can be located with accuracy, and it is clear that with so few points, and also with so few observations, no satisfactory result could be obtained. This investigation was therefore closed, and our results secured by means of latitudes are given as our final figures.

Private Observatory, Mandeville, Jamaica, B. W. I.,
December 4, 1925.

NOTE ON THE PRESENCE OF OXYGEN IN THE ATMOSPHERE OF MARS.

Since writing Report No. **31** my attention has been called to the fact that in referring to the existence of both water vapor and oxygen in the atmosphere of Mars, although I had mentioned the Lowell Observatory in connection with the existence of the former, I had quite overlooked the important fact that the presence of oxygen in the Martian atmosphere had first been proved as long ago as 1909 at the Lowell Observatory, Lowell Bulletin No. 41. This was accomplished by means of spectra photographed by Dr. V. M. Slipher and measured by Professor F. W. Very. The latter found that the percentage in the Martian atmosphere, as judged by the intensity of the B line, was 15 percent of that reflected to us by the moon through the earth's atmosphere. Since the light received by us from Mars passes twice through its

atmosphere, this would imply that that atmosphere contains 7.5 percent as much oxygen as our own. This very conservative estimate by Professor Very has been doubled by the Mt. Wilson observers.

OMAR KHAYYAM, POET ASTRONOMER.*

The Persian poet, famous for his collection of quatrain poetry, was also a scientist and an astronomer. He composed some astronomical tables and some works upon natural sciences and metaphysics. Two of his books, which treat of algebraic problems and the geometry of Euclid, have also come down to us.

The poetry of Omar Khayyam contains, however, few allusions to the studies which occupied the larger part of his life. His bitter and restless spirit saw only vanity in science as well as in philosophy, and if he speaks of them it is always with disillusioned contempt: "I have associated with doctors and sages," said he, "but I have always left their assemblages even less wise than when I came."

His value as an astronomer was, however, indisputable and his place in science much more important than we should believe on reading his verses. The sultan Malik entrusted him with the direction of the Kiew Observatory, and he was one of the scientists who took a foremost part in reforming the calendar. This took place in 1074, which shows that this problem greatly interested the astronomers of those times just as it does today.

In one of his quatrains, the poet recalls the work which he accomplished on this subject; but the study of the calendar only increased his disenchantment and strengthened his conviction that we should make haste to enjoy a little of the time which we have to live here.

The impossibility, where we are, of comprehending the cause of human destiny haunts the mind of our poet. The sky is deaf to his questions, and Khayyam is afraid, like Pascal, of the silence of these infinite spaces. He describes, using the language of the science of his time, the implacable laws which regulate the movement of the stars, and impeaches the merciless influence of the stars over our destiny.

"Everything is only a play of the magic lantern. The Sun is the candle around which we revolve like shadows." But even if he is fatalistic, Khayyam does not share the resignation of his race. He rises in insurrection against the implacable laws which, according to him, have neither justice nor pity. "Indefatigably, the Pen writes that

*From *L'Astronomie*, Paris, France: May, 1925, pp. 224-226. A part of an article written by Pierre Salet. Translation by Charles Nevers Holmes, 18 Pearl St, Reading, Mass.

which will be, without concerning itself with the good or the bad results. Our suffering and our efforts are in vain."

And the poet astronomer, in order to represent the overwhelming sensation caused by the celestial laws to which we are subject, compares the heavens with an overturned vase which imprisons us. "This celestial vault is like a fallen bowl, with the bottom in the air—and under which the sages live, confined."

Khayyam felt, however, the universality of the life which circulates throughout all the Universe. He is well aware that after him "thousands of another Khayyam" will be created incessantly, and he compares all these successive beings with bubbles of wine that succeed themselves endlessly in the cup of Creation.

We see that if Khayyam speaks seldom of astronomy in his celebrated quatrains, the study of this science and the severity of the reasoning that he received from it, count for much in the formation of his philosophic thought. It is the regularity of celestial movements which convinced him, at first, of the implacable determinism, which, for him, ruled the Universe; and it is the revolt of his mysterious mind against these blind laws which led him into pessimism. It is indeed astronomy, or at least that which this science was in the eleventh century, that is the foundation of the great Persian poet's very bold and original philosophy

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AMERICAN ASTRONOMICAL SOCIETY.

REPORTS OF OBSERVATORIES
1924-1925

(Continued from page 37.)

DOMINION OBSERVATORY

OTTAWA, CANADA

Staff. There were no changes in the scientific staff during the year.

Meridian Work and Time Service. Meridian circle observations were continued on the same program as previously. Over 3,800 observations on stars and 104 on the sun were made in right ascension and declination. The meridian circle is reversed on its axis about the beginning of each month.

No material changes have been made in the time service in the Government buildings during the year. Wireless time signals from Annapolis, Lafayette and Nauen have been observed regularly. Special signals were also observed as required for survey purposes. Wireless signals have been broadcasted twice weekly at 9:00 P. M. through the Canadian National Railways broadcasting station. A certain amount of experimental work on transmission and reception has been done in collaboration with the United States Bureau of Standards and other institutions.

Solar Physics. Over 500 photographic observations of spectra of solar limbs, midway and center points, were made with iodine comparison spectra, and in some cases spectra of electric arcs under standard conditions and at reduced pressures. The observations were made chiefly at λ 5600 and a few at λ 5200. A motor-driven vacuum pump with electrically controlled leak was installed to control the pressures in the vacuum-arc chambers, similar to that already used for the iodine tubes. A motor-driven masking device was installed to secure even densities in the 9 strips of spectra photographed simultaneously. About 750 observations of the solar rotation were measured, consisting mainly of the 1910 observations at λ 4500 and λ 5600.

Radial Velocity. About 1000 spectrograms were secured with the aid of the 15-inch equatorial for the determination of radial velocities. A complete study of ν Eridani was made. σ Scorpii was followed as usual through the spring months. The Cepheids ζ Geminorum and η Aquilae were specially investigated to determine the shifts of spectral lines arising supposedly from different levels, as well as the variation in ionization in these stars. Several spectroscopic triple systems have been discovered and put on the program for continuous study, together with some known triple systems (among them ϵ Aurigae, λ Andromedae and σ Geminorum).

Photographic Photometry. About 100 plates covering over 40 fields were obtained with the 6-inch and 8-inch cameras for determining magnitudes of comparison stars in the fields of Cepheid variables. The equatorial mounting supporting three photographic cameras of 2-inch aperture and 13-inch focal length has been completed. With this instrument about 450 plates were made, to be used in the determination of photographic light-curves of Cepheid variables for comparison with the radial-velocity curves obtained spectrographically.

Seismology. During the year 320 earthquakes were registered and have been reported by monthly bulletin as usual. Of these the Ottawa Valley tremor of July 14, the shock in eastern Canada of September 30, the St. Lawrence quake of February 28, the Montana disturbance of June 28, and the destructive tremor in Santa Barbara June 29, deserve special mention. Well marked earthquakes have been reported, as in the past, to the Canadian press, and also latterly to Science Service, Washington. The instruments at Ottawa, Halifax and Saskatoon have

functioned continuously, and a single-component Milne-Shaw seismograph has been installed at Ste. Anne de la Pocatiere, P. Q. The Ottawa valley quake of July 14 and the St. Lawrence quake of February 28 were investigated by questionnaires and by visits to the epicentral region.

Terrestrial Magnetism. During the season of 1924, declination, dip and horizontal intensity were determined at 23 stations located in western Canada along the Pacific coast and in the Yukon. Ten of these were relocations to secure data on secular variation. During 1925 observations are being carried on at repeat stations in the eastern provinces.

Gravity. During the 1924 season 20 stations were occupied in Saskatchewan, Alberta and British Columbia; and during 1925 a further series in these provinces and in Manitoba.

Eclipse of January 24, 1925. A small party was sent to Long's Corners near Hamilton, Ontario, to observe variations in the magnetic elements and effects on reception of radio signals caused by the eclipse. The sky was overcast during the eclipse, but this of course did not interfere with the main objects of the expedition, which were carried through successfully.

Publications. Five of the regular series of *Publications of the Dominion Observatory* were issued during the year, as well as a number of articles in various scientific magazines.

R. Meldrum Stewart, *Director.*

MOUNT WILSON OBSERVATORY

Carnegie Institution of Washington

Pasadena, California

A very important addition to the equipment of the Observatory was made by Dr. Hale during the year when he gave to the Carnegie Institution of Washington the new Solar Laboratory with its buildings, ground and instruments. The work carried on by Dr. Hale at the Solar Laboratory will form an integral part of the research of the Observatory and will extend and supplement in many respects the investigations on Mount Wilson. The dome and coelostat mounting for the telescope have been completed, and much progress has been made upon the 75-foot spectrograph, the spectroheliographs, and other auxiliary apparatus.

In accordance with the wishes of the late Dr. Woodward, former president of the Carnegie Institution of Washington, the Observatory has received over 600 volumes, relating mainly to mathematics and the physical sciences, which were contained in his personal library. These

have been suitably marked and incorporated in the Observatory library of about 8,500 bound volumes.

The staff of the Observatory has remained without material change during the year. Professor Frederick H. Seares was appointed assistant director on January 1, 1925. Of the Research Associates, Dr. A. A. Michelson and Dr. Henry Norris Russell each spent several months in Pasadena, and Dr. J. H. Jeans visited the Observatory and lectured before the members of the staff on certain aspects of his theories on cosmogony. A series of three lectures by Professor A. S. Eddington on radiative equilibrium and the interior of stars, and a discussion of vortices and solar theories by Professor V. Bjerknes were important features of the visits of these scientists to the Observatory. Dr. John C. Duncan, director of the Whitin Observatory, and Dr. Henri L. Vanderlinden of the Royal Observatory of Belgium each spent a portion of the year in Pasadena and were engaged in special research problems. Professor Edna Carter of Vassar College carried on investigations in the physical laboratory on the spectra of the alkali elements in the vacuum spark, and Dr. S. Rosseland, research fellow of the International Education Board, has continued his investigations on atomic radiation and absorption and its astrophysical applications.

Three members of the staff, Messrs. Anderson, Nicholson, and Pettit, secured successful observations of the total solar eclipse of January 24, 1925, at Middletown, Connecticut. The Observatory was represented at the Cambridge meeting of the International Astronomical Union in July by Messrs. St. John, Babcock, and van Maanen. Mr. St. John was also a delegate to the Brussels meeting of the International Research Council.

Observing conditions throughout the year were below the average, the number of hours devoted to work at the telescopes being about 10 per cent below the mean for the past 13 years. The precipitation was 35 per cent below normal, but extensive forest fires interfered with observations on several occasions, and light cirrus clouds were unusually prevalent.

Summary of the Year's Work.

Observations of the polarities of sun-spots of the new cycle continued throughout the year have provided ample confirmation of the reversal of polarity announced by Hale last year. Only one of the 70 groups of spots belonging to the new cycle which have been observed magnetically failed to show the reversal. The increase in the number of spots has furnished much new material for the study not only of polarities but also of vortex structure around spots. As a result of his investigations Hale finds that the observed polarity is independent of the direction of rotation of the vortex as indicated by the structure shown on the spectroheliograms, and concludes that the evidence points to a hydrodynamical rather than an electromagnetic explanation of the hydrogen vortices around sun-spots. In the course of this study Hale

finds that about 75 per cent of the hydrogen vortices associated with single or preceding spots in the two hemispheres of the sun correspond in direction of whirl with terrestrial storms, irrespective of the 11½-year cycle in which they occur. Recent measures of the same general magnetic field by van Maanen show that the sign of the field has remained the same since the first measures were made. During this time the magnetic polarities of sun-spots have reversed twice.

Measurements of the ultra-violet radiation of the sun with the thermocouple commenced by Petfit last summer are being continued systematically during the present year. These results, which show fluctuations of the order of 100 per cent and a general increase since May, 1924, should bear an important relationship to the solar constant which Abbot finds to show its greatest variations in the ultra-violet.

At the total eclipse of January, 1925, Pettit and Nicholson secured measurements of the radiation of the solar corona with the use of a vacuum thermo-couple and photometric apparatus. These yielded absolute values of the radiation of the corona in terms of sunlight and showed that the corona gives more blue and less red radiation than the sun, the corona being redder near the limb than farther away.

The measurements by St. John and Babcock of the wave-lengths of lines in the solar spectrum have made important progress during the year A total of about 2,500 lines measured on the international system is now available, distributed throughout nearly the whole of the region covered by Rowland's table. This material has been used to construct a reduction curve for the revision of Rowland's *Table of Solar Wave-lengths*. St. John's measures of over 400 lines in the cyanogen fluting show displacements of almost exactly the amount predicted from the theory of relativity.

Observations have been continued by St. John on the rotation of the sun. A decrease of about 2 per cent in the linear velocity is shown by the results of the last six years when compared with those of the preceding five years. Considered in the light of the results of previous observers this change suggests the possibility of a variation of rotation associated with the reversal of sun-spot polarities, the indicated change for 15 years being about 8 per cent.

The measures of planetary radiation by Pettit and Nicholson have yielded values of the temperature of Mercury, Venus and Mars. The temperature of the south polar cap of Mars was found to be 55° C below that of the limb in the equatorial regions. Drift curves taken across the image of Mars indicate an atmosphere which can absorb but very little planetary radiation. This conclusion is in agreement with the spectrographic results of Adams and St. John made in February. These showed the presence of only 6 per cent as much water vapor and 16 per cent as much oxygen in the Martian atmosphere as were present over Mount Wilson at the time of observation. The temperature derived for the sub-solar point of Mercury at mean distance is 710° absolute. The temperature indicated by the radiation

from the dark side of Venus is 250° absolute.

In the field of stellar and nebular investigations many results of interest have marked the work of the year. Hubble's discovery of Cepheid variables in spiral nebulae and his determination of their light-curves have enabled him to derive distances and linear dimensions for several of the larger spirals. The Andromeda Nebula with a distance of about 900,000 light-years and a diameter of 50,000 light-years is the most important of these. The distance found for M 33 is also about 900,000 light-years. That of the object N. G. C. 6822, resembling the Magellanic Clouds, is only slightly less.

Seares has made a new determination of the distribution of stars according to magnitude and galactic position based upon the completed material of the Selected Areas. This gives a total of 890,000,000 stars to the twenty-first photographic magnitude, with 40 times as many stars in the Milky Way as at the galactic poles. A new discussion of the number and distribution of the nebulae has also been completed by Seares and yields a total of 210,000 nebulae to photographic magnitude 18.6 between 70°N and 70°S, with about 300,000 for the entire sky.

Strömberg has continued his studies of the asymmetry of cosmical velocities. Using all available radial velocities and a grouping of the various classes of objects according to the quantity $H = m + 5 \log \mu$, which is closely correlated with absolute magnitude, he finds a definite relationship between the internal dispersion in velocity for each class of stars or nebulae and a common axis of preferential motion. This asymmetry of motions is thus seen to be a fundamental property of all celestial objects.

An investigation of the spectrum of the "white dwarf" companion of Sirius by Adams has resulted in a close confirmation of the displacement of the lines predicted by Eddington on the theory of relativity and would appear to indicate a density for this star about 50,000 times that of water. Spectrograms made with the 100-inch reflector were measured both directly and with the registering microphotometer. The measured displacements corrected for scattered light and orbital motion give a mean of +0.32 A. The value predicted by Eddington on the basis of relativity is +0.31 A.

Successful measurements have been carried out by Pease with the 20-foot interferometer of the diameter of the long-period variable star o Ceti and yield a probable diameter at maximum of light of about 430,000,000 kilometers. Measures have also been made of the spectroscopic binary star Mizar with a period of 20 days, thus making this star the shortest-period visual binary so far observed.

Further stellar investigations have included parallax and proper motion determinations by van Maanen, including completed parallaxes for 16 fields, and proper motion measures of M 13 which show that the displacements corresponding to internal motions in this distant cluster are vanishingly small; studies of the colors of stars as related to ap-

parent magnitude and galactic latitude by Seares; about 275 radiometric observations, principally of variable stars, by Pettit and Nicholson; an investigation of the colors of Pseudo-Cepheids by Seares; physical studies of the spectra of bright-line B-type stars by Merrill and Humason, showing that these stars present a strong preference for types B0 to B3 and tend to occur in groups near the center line of the Milky Way; an investigation of long-period variables and stars with peculiar spectra by Merrill; a detailed research on the spectrum of o Ceti and its companion by Joy; measurements of radial velocity and determinations of absolute magnitude for a large number of stars, especially of the dwarf class, by Adams, Joy, Sanford and Humason; and a further examination of the spectra of irregular and spiral nebulae with an objective prism by Hubble.

In the physical laboratory the use of the high-current arc by King has resulted in the production of spectra showing notable characteristics intermediate between those of the furnace and the spark, and provide a valuable means of classifying and grouping lines beyond the reach of the furnace. Anderson by using the large condenser and variable inductance has been able to obtain spectra which, with a current of 1000 amperes, resemble those of the high-current arc, but with higher currents change radically. Nearly all the bright iron lines, with the exception of the less refrangible spark lines, are reversed upon a strong background of continuous spectrum. These investigations have developed the means of obtaining a series of steadily increasing excitations, subject to the control of the observer, which range from the lowest temperatures in the furnace to those produced by currents of several thousand amperes. An important consequence is the opportunity afforded of making quantitative studies of the continuous spectrum and the possibility that such studies suggest of a rational explanation of the origin of continuous spectra.

A method has been devised by Anderson for photographing a spark or exploding wire with an exposure which is very short as compared with the duration of the phenomenon itself. The principle used is the magnetic rotation of the plane of polarization, a small water cell surrounded by a few coils of wire being placed between two Nicol prisms with planes set at 90° to one another. Exposures of a few millionths of a second have been obtained by this means and the method is proving most successful in the study of the successive phases of spark and wire explosions.

Babcock has continued his measurements of the wave-lengths of iron lines in the laboratory with the interferometer, giving special attention to the slight systematic differences found among different observers. His application of the interferometer to the study of the displacements of iron lines under small changes of pressure has yielded interesting results which confirm in general the Mount Wilson classification into groups, and show a proportionality between displacement and pressure between 0 and 1 atmosphere. Due probably to the elimination of the

pole effect, however, the absolute values of the displacement are only about one-half as great as those found by other observers.

Other investigations in the laboratory have included studies of the spectra of the alkali metals in the vacuum spark by Miss Carter; the furnace classification of the lines of yttrium, lanthanum, and zirconium by King; and interferometer measurements of solar lines by Babcock.

Successful measurements of the velocity of light were secured by Dr. A. A. Michelson, research associate of the Observatory, in August, 1924. between the Mount Wilson and San Antonio stations. A series of 8 sets of observations gave a value of 299820 km/sec *in vacuo* with an accuracy of probably 1 part in 10,000. The investigation will be continued with certain improvements in the apparatus, which should still further increase the accuracy.

Dr. H. N. Russell, research associate, while in Pasadena developed theoretical formulae for the intensities of multiplet groups of spectral lines, later found to be identical with results found independently by Kronig and by Sommerfeld and Hönl. The predicted intensities based on the correspondence principle are closely proportional to the squares of King's estimates on an arbitrary scale. This affords strong support for the validity of the principle, and clears the way for quantitative determinations of the relative numbers of absorbing atoms active in the production of Fraunhofer lines. Dr. Russell has also compiled and published a list of 2200 ultimate and penultimate lines of astrophysical interest, which has already proved of much value.

The construction division, including the department of drafting and design and the optical and instrument shops, has carried on its usual activities. Drawings have been made for the 75-foot spectrograph and the attached 13-foot and 30-foot spectroheliographs of the Solar Laboratory; for the apparatus used by the 1925 and 1926 eclipse expeditions; and for many pieces of miscellaneous apparatus used in the laboratory and on Mount Wilson. Much of the time of the optical and instrument shops has been devoted to the construction of instruments for the Solar Laboratory.

The most serious fire in the Angeles National Forest for many years started on August 31, 1924, to the eastward of Mount Wilson and lasted throughout the entire month of September. During much of this time Mount Wilson was threatened directly, and the mountain top soon became one of the chief centers from which the forces fighting the fire were directed.

WALTER S. ADAMS, *Director.*

UNITED STATES NAVAL OBSERVATORY

WASHINGTON, D. C.

Changes in the staff in the year ending June 30, 1925: CAPTAIN W. C. ASSERSON, U. S. N., Assistant Superintendent, and head of Department of Material, vice CAPTAIN A. KAUTZ, U. S. N. *Magnetic Compasses, Air Navigation, and Aerological Instruments:* COMMANDER WILLIAM H. LEE, U. S. N., vice COMMANDER W. L. BECK, U. S. N.

The Naval Observatory has continued its regular duties of making accurate observations of position, and has supplied the navy and the country in general with astronomical data, including the *American Ephemeris and Nautical Almanac*.

The material department has been engaged in the development, supply, and repair of all navigational and surveying instruments used by the navy.

Also, the Naval Observatory has sent out twice daily accurate time signals, both over the telegraph lines, and by radio from Arlington and Annapolis. The average error of all signals during the year was $0^s.032$. The lags of Arlington and Annapolis are now measured for each signal, and the results furnished with the monthly list of time-signal corrections.

Special observations for time were taken with the 6-inch transit circle on 132 nights, and with a Prin portable transit on 73 nights. The 6-inch was reversed 69 times. The Prin transit was reversed on each star. The monthly differences of clock corrections as found from the two instruments range from $+0^s.031$ to $-0^s.010$ in the sense Prin minus 6-inch. The mean difference for the year is $+0^s.017$.

The time signals from the Lafayette radio station, Bordeaux, France, have been automatically recorded at the Naval Observatory. From March to December, 1924, the range of the differences of the monthly means between Washington and Paris is $0^s.20$.

At the request of the Canadian Government and of the United States Coast and Geodetic Survey special time signals were sent from the Naval Observatory during the summers of 1924 and 1925, and from San Diego in 1925. These were used by the Canadian Government; and by the Coast and Geodetic Survey for longitude determinations in the Mississippi Valley, Alaska, and the western Aleutian Islands. Also these signals were used by observatories in Mexico, New Zealand, and Australia.

The round-the-world longitude operations have been postponed until October, 1926.

In accordance with international agreement the *American Ephemeris and Nautical Almanac* for 1925 began the astronomical day at midnight, at the same time as the civil day.

A new star catalogue has been issued, Positions and Proper Motions of 1504 Standard Stars. It is Volume X, part I, of the *Astronomical*

Papers of the American Ephemeris. Also, Volume X, part II, *Publications of the United States Naval Observatory,* Second Series, has been issued. This contains the results of the two total solar eclipse expeditions sent out by the Naval Observatory, to Spain and Africa in 1905, and to Baker, Oregon, in 1918. Also, there is included the results of airplane observations of the total solar eclipse in California in 1923.

Volume X, part I, of the *Publications of the United States Naval Observatory,* Second Series, is being printed at the Government Printing Office. This contains observations taken with the prime vertical transit during the years 1893-1912, inclusive, with a discussion of the observations. There are 7,947 observations, including 1,867 of α Lyrae. Among the results are a catalogue of the declinations of 368 stars, and a determination of the annual parallax of α Lyrae and its proper motion. Also, from the observations of α Lyrae are derived corrections to the constants of aberration and nutation. From the Küstner polygon method, which was adopted during the period 1904-1912, is determined a correction to the aberration constant. Also, there is presented in the volume a discussion of the daily variations of the declination of α Lyrae.

The total solar eclipse of January 24, 1925, was observed by the Superintendent and a Naval Observatory party from the U. S. S. *Los Angeles,* over the ocean east of Long Island. As a partial eclipse it was observed visually and photographically at the Naval Observatory.

Congress having appropriated money for the observation of the total solar eclipse of January 14, 1926, arrangements were made to send a Naval Observatory party to Sumatra, where they arrived October 19, 1925.

A considerable number of contributions have been made by the Naval Observatory staff in the way of articles published in the scientific journals and papers read before the American Astronomical Society.

In consequence of reclassification the pay of the civil service employees of the Naval Observatory has been increased, though in many cases the salaries are not adequate for the services rendered.

Three thousand, one hundred and thirty-three visitors were admitted at night during the year, to view the heavens through the telescopes.

During the meeting of the American Astronomical Society in Washington sessions were held at the Naval Observatory through one day. Also, the members of the Society inspected the instruments, and learned at first hand regarding the activities of the institution.

Nautical Almanac Office

The *American Ephemeris and Nautical Almanac* for 1927 was received from the printer on June 8, 1925. The *American Nautical Almanac* for 1927 was sent to press on May 21, 1925.

All of the copy of the *American Ephemeris and Nautical Almanac* for 1928 has been sent to the printer, and 316 pages are in type.

The investigation of the orbits of Saturn's satellites has been continued. One hundred and thirty-eight sets of corrections to the elements have been obtained from 18 pairs of satellites, and equations of condition have been formed for 57 more sets, covering in all 22 oppositions.

The work on the determination of the orbit of Neptune's satellite based on 1,639 observations made during 33 oppositions, from 1889 to 1923, is ready for publication.

DEPARTMENT OF ASTRONOMICAL OBSERVATIONS

6-inch Transit Circle and Prin Transit. With the Prin transit were observed 441 time stars and 64 azimuth stars.

With the 6-inch, observations of the moon were begun on December 14. On May 16 was begun a new program of work, comprising the sun and planets as well as the moon. 1,618 observations were made, which number includes clock stars, time stars, and azimuth stars.

Lack of printing funds has prevented the publication of the results of the 50,000 observations of the sun, Mercury, Venus, and standard stars made during the period 1909-1918. However, the manuscript is completed, and will be published as soon as money is available.

Clock Vault and Clocks. The temperature of the clock vault was maintained practically constant during the year at 84° F. The three standard Riefler clocks performed satisfactorily.

9-inch Transit Circle. The total number of observations of standard and intermediary stars, sun, moon, and planets was 4,402. The total number of observations made since the beginning of this work in 1913 is 72,036.

Observations of the sun, moon, and planets with this instrument were discontinued in February, 1925, and except for a little miscellaneous work still to be done, the observations of the intermediary and standard stars were completed in June, 1925.

Equatorials. With the 26-inch equatorial, observations were made as follows: Comparison stars, 9; occultations, 27; eclipses of Jupiter's satellites, 2; Comet Encke, 19; Comet 1924*c* (Finsler), 10; Comet 1925*a* (Shajn-Comas-Solà), 7; Comet 1925*b* (Reid), 5; Comet 1925*c* (Orkisz), 6; Comet 1925*d*, (Tempel II), 2; asteroid 1923 NT, 7; asteroid 1924 TD, 54; double star system 70 Ophiuchi, 34; satellites of Mars, 114; satellites of Saturn, 32; satellite of Neptune, 11.

With the 12-inch equatorial were observed 22 occultations, and the partial solar eclipse of January 24, 1925.

It is expected to have an equatorial volume prepared for publication at the close of the fiscal year 1926.

Photographic Equatorial. This instrument has not been in operation

during the present year. Photographs of asteroids previously made have mostly been measured, and are now with the Computing Division for reduction.

Photoheliograph. Photographs of the sun were made on 247 days. There were spots on 213 days. There has been a notable increase in solar activity.

The Naval Observatory has continued to coöperate with the Western Union Telegraph Company in an exchange of data as to the relation of solar disturbances to auroras and magnetic storms.

Photographic Zenith Tube. The results for 1924 have been sent to the *Astronomical Journal.* The value of the aberration constant from the year's observations is $20''.429 \pm 0''.010$, and the value from the nine years' work is $20''.454 \pm 0''.005$. The number of observations secured during the year was 2,159.

Prime Vertical Transit. During the year 535 observations of declination were made.

Library. The library contains 39,000 volumes and pamphlets, 695 having been added during the year. The collection is particularly rich in the publications of the scientific academies of Europe, and in complete sets of the mathematical and astronomical journals. Use is made of the library by investigators from all parts of the country.

EDWIN T. POLLOCK, Captain U. S. N., *Superintendent.*

PRINCETON UNIVERSITY OBSERVATORY

PRINCETON, NEW JERSEY

There have been no changes in personnel nor significant alterations in buildings and equipment.

Theoretical Researches. Mr. Russell has been engaged mainly in spectroscopic investigations, some of which were undertaken at Mt. Wilson (see Mt. Wilson report), and upon problems connected with stellar evolution. The list of spectral lines for which series classification is available has been published; also a paper on the intensities of lines in multiplets; a discussion of the spark spectrum of calcium, prepared jointly with Professor Saunders; and a paper in *Nature* on stellar evolution.

Miss Moore has rendered very valuable assistance in the spectroscopic investigations.

Mr. Stewart has continued the study of the theory of gas opacity, and during the year has published papers on the relation between selective and general opacity in the outer portions of a star, and on the width of Fraunhofer lines—amplifying a theory he had previously proposed. A compilation of various formulae (analogous to that of

Rayleigh) dealing with the scattering of radiation by gas-molecules will be printed in the December issue of the *Journal of the Optical Society of America.*

In addition a brief discussion was published of the electrostatic field in an ionized gas in a gravitational field, giving an extension of Pannekoek's treatment to the case when different types of ions are present.

A large part of the time of the staff has been occupied with the preparation of a revision of Young's *Manual of Astronomy*, which, at the date of writing, is nearing completion. This has especially curtailed the observing program.

Observational Researches. Mr. Dugan made a total of 3,792 photometric measures, during October and November, 1924, of the eclipsing variables Y Cygni, TY Pegasi, X Trianguli, W Ursae Minoris, and RT Sculptoris; and 208 of a primary minimum of RT Persei on March 19, 1925. The observation of RT Sculptoris was concluded, and that of X Trianguli very nearly. *Contributions* No. 7 (McDiarmid) was edited and published.

Miss Moore has measured and reduced 16 of the Harvard lunar plates.

HENRY NORRIS RUSSELL, *Director.*

SMITHSONIAN ASTROPHYSICAL OBSERVATORY

WASHINGTON, D. C.

Personnel. The Observatory operates two field stations: Mount Montezuma, near Calama, Chile, Hugh B. Freeman, director, F. A. Greeley, assistant; Mount Harqua Hala, Arizona, A. F. Moore, director, E. E. Smith, assistant. At Washington, where computing, publication, and preparation of instruments is attended to: C. G. Abbot, director; F. E. Fowle and L. B. Aldrich, aids; Mrs. A. M. Bond, computer; A. Kramer, instrument maker.

Field Work. As for several years past, there were maintained at Mount Montezuma and Mount Harqua Hala two stations for the daily observation of variation of solar radiation. Telegraphic reports were made from each station to Washington each day, giving the mean values and their character. From these reports were made up the best representative values, which were telegraphed to Mr. H. H. Clayton, of Canton, Massachusetts, for use in his studies of the dependence of world weather on solar variation. It is usual to make five independent morning measurements at each station, compute the solar constant values corresponding, and wire the mean value by evening of the same day.

The weighted mean reaches Mr. Clayton about twenty-four hours after the observations are made. He mails, on the same afternoon, a solar forecast of the temperature for New York City, 3, 4, and 5 days

after the date of observing the sun. Also, on Friday of each week, he forecasts the mean New York temperature departure for the week following, and, near the close of each month, the mean New York temperature departure for the ensuing month.

These long-range forecasts, after being continued over a year, have been compared with the events by the staff of the Astrophysical Observatory, and they indicate a real prevision by Mr. Clayton, both as regards the definite temperatures after 3, 4, and 5 days, and as regards the general forecasts for weeks and months. The correlations are not very high, but seem real, and are regarded as of great promise in connection with further investigations. Neither the Smithsonian Institution nor Mr. Clayton publishes these forecasts. They are purely for experimental test purposes. The Institution has no responsibility for so-called forecasts of seasons far in advance which have been attributed to it in public prints.

Daily telegrams are sent from Mount Montezuma to the Chilean and Argentine weather services. In Argentina they have been used for six years as a basis for definite forecasts of daily temperatures and rainfall of Buenos Aires a week in advance. In Chile, investigations of these relations are just beginning.

Four papers, Nos. 2818, 2825, 2826, and 2827, of the *Smithsonian Miscellaneous Collections,* were published in 1925, giving results and tests of these matters.

By invitation of the director of the Mount Wilson Observatory, Mr. Abbot made some further attempts to observe star spectra with the radiometer in connection with the 100-inch telescope. No great advance was accomplished over the results of the preceding year in actual observations, but valuable experience was gained which should make great advances possible in future work.

Mr. Abbot also rebuilt the solar cooker on Mount Wilson with many decided improvements. Still others remain uncompleted. A series of observations was made by him on Mount Wilson, using Fabry's method, to measure the variations of atmospheric ozone. These results, covering about 50 days of the autumn of 1924, are as yet unreduced.

Work at Washington. Besides preparing for publication papers 2818, 2825, and 2827, above mentioned, including the collection and checking of results on the solar constant of the years 1918 to 1924, a great deal of computation has been undertaken for the purpose of improving the methods of reduction of solar constant observations. Whereas the average difference between daily observations at Montezuma and Harqua Hala at present is approximately 0.5 per cent, it is desired to reduce this divergence to still smaller proportions in order to meet the meteorological requirements which appear in Mr. Clayton's researches. This requires a very careful study and attention to details heretofore overlooked, which will be the subject of much study in the months to come.

C. G. Abbot, *Director.*

SPROUL OBSERVATORY

SWARTHMORE COLLEGE

SWARTHMORE, PENNSYLVANIA

During the past year the staff of the Observatory has been working on four main problems: stellar parallaxes, photographic observations of double stars, photographic magnitudes of variable stars, and total solar eclipses.

1. The 24-inch visual refractor was used on 131 nights. On comparatively few of these nights was the seeing good enough to allow us to continue work throughout the night. 382 parallax plates were secured. *Sproul Observatory Publication* No. 8, containing the fourth list of fifty parallaxes, was published and distributed. The average number of plates used in each determination was 14.5 and the average probable error of the parallax $\pm 0''.0092$.

2. Between the evening and morning parallax programs 150 measurable double-star plates were secured. Each plate contains three or more exposures, the shift from one exposure to another being made with the electric slow motion. These plates have been measured in duplicate by Mr. Marriott and Miss Onderdonk. The detailed results will be published later.

3. Mr. Dean B. McLaughlin, who joined our staff in September, 1924, has started a photometric program with the 9-inch camera. At present, he has 19 variables under observation and has secured 56 photographs. On one or more plates of each series will be impressed a Harvard sequence from which the magnitudes of the comparison stars will be determined.

4. The major portion of the time of the staff during the past year has been devoted to work on total solar eclipses. *Sproul Observatory Publication* No. 7, "Observations of the Total Solar Eclipse of September 10, 1923, by the Sproul Observatory," was published and distributed. The summer and fall of 1924 was used in making some necessary alterations in the eclipse instruments and preparing to observe the eclipse at New Haven on January 24, 1925. The instruments used there were, as follows: four cameras with varying focal lengths and apertures, two objective gratings and two Etalon interferometers. The focal length and aperture of each of the cameras respectively were: 62.5 ft. and 9 in.; 15 ft. and 6¾ in.; 72 in. and 5 in.; and 17 in. and 2½ in. Of the two gratings, one was adjusted to the blue end of the spectrum and the other to the infra-red. The results obtained were published in *Popular Astronomy*, Vol. **33**, No. 6, June-July, 1925. Mr. McLaughlin, at the invitation of Miss Furness, made a series of photographs of the eclipse in the partial phases and during totality with the Vassar Observatory telescope. Most of the instruments used at New Haven have been shipped to Sumatra where Messrs. Miller, Marriott

and McLaughlin, together with H. D. Curtis of Allegheny Observatory, will observe the eclipse of January 14, 1926.

JOHN H. PITMAN, *Acting Director.*

VAN VLECK OBSERVATORY

WESLEYAN UNIVERSITY

MIDDLETOWN, CONNECTICUT

Mr. N. W. Storer resigned at the end of the year to accept a fellowship at the Lick Observatory. Dr. C. L. Stearns, formerly of the Yale Observatory, has been added to the staff as research associate.

The parallax program has been continued, concentrating chiefly on faint stars of large proper motion. During the winter very few plates were secured, partly on account of bad weather, partly on account of the preparations for the total eclipse of the sun of January 24, 1925, which was visible here. Thirty astronomers, representing fifteen institutions, were located in or near this Observatory. The sky was clear and the programs of all the parties were successfully carried out. See *Popular Astronomy*, **33**, 169, 1925.

Messrs. Slocum and Sitterly have continued to devote considerable time to teaching.

FREDERICK SLOCUM, *Director.*

WASHBURN OBSERVATORY

UNIVERSITY OF WISCONSIN

MADISON, WISCONSIN

There have been no changes in personnel during the year.

The 15-inch refractor was used on eighty-eight nights on the regular program with the photo-electric photometer. It is expected during the coming year to bring to completion the tests of spectroscopic binaries and comparison stars begun at the University of Illinois in 1916. The results for variable and constant stars will be published in the near future.

In collaboration with Dr. Jakob Kunz of the University of Illinois, an eclipse expedition was sent to Middletown, Connecticut. Under the unexpectedly favorable conditions at the time of totality, photometric measures were made of the solar corona comparable with those with the same apparatus in 1918. The results show that there is no appreciable variation in the total light of the corona between maximum and minimum of sun-spots.

The manuscript on proper-motion stars by the late Mr. Flint was completed, and is now going through the press.

JOEL STEBBINS, *Director.*

YALE UNIVERSITY OBSERVATORY

NEW HAVEN, CONNECTICUT

Personnel. Mr. C. H. Davis, who had been temporarily engaged for the purpose of assisting Mr. Brown in computations on the Trojan group of planets, finished his work in May, 1924. Mr. Claude H. Hall was appointed to the rank of computer in September, 1924, to assist in assembling and installing the new telescope. Mr. Harold Lee Alden, assistant professor of astronomy at the University of Virginia, was appointed assistant professor of astronomy at Yale beginning May 1, 1925; he is to have charge of the Yale station at Johannesburg. Mr. Schlesinger was absent from the Observatory from December 25, 1924, to September 1, 1925, and Mr. Brown was acting director during this period of eight months.

The Loomis Coelostat Telescope. Mr. Stearns continued his work on variable stars with this telescope until January, 1925. The interruption caused by the total eclipse and the work of measuring and reducing some of the plates secured on that occasion prevented any further observing with the Loomis telescope during the remainder of the year.

The Reed Telescope, an eight-inch visual refractor, has been used a good deal in recent years for visitors. This year we were forced by the pressure of other demands upon the time of the Observatory staff to curtail this service a good deal. Tickets were issued on eight nights to 168 visitors. In addition the telescope was frequently used in connection with the course in Astronomy, 10a.

The Zenith Camera, a ten-inch photographic instrument intended for observing variations of latitude. Mr. Stearns continued to obtain plates throughout the year. The observations necessary for this experiment are now complete; it remains to finish the reductions and to discuss all the material.

The Catalogue Camera. Almost all of Miss Barney's time and that of two computers, as well as a good deal of Mr. Schlesinger's time, has been occupied in this department of the Observatory. From plates secured with a camera that covers 5° by 5°, Mr. Schlesinger and Miss Barney completed their "Catalogue of 8,359 stars between declinations 50° and 55° north," which has since been distributed as Volume 4 of the *Transactions of the Yale Observatory.* This catalogue is a re-observation of all the stars in the corresponding part of the great *Astronomische Gesellschaft Catalogue* carried out forty years ago. A comparison of the two yields the very large number (more than 8,000) of fairly accurate proper motions that appear in our Volume 4. This catalogue demonstrates the economy and superior accuracy of photographic methods for such work. Encouraged by this outcome, we intend to continue the re-observation of other parts of the *Gesellschaft*

Catalogue, either with fields of this size or with the much larger ones (10°x15°) with which we are now experimenting. Miss Barney has measured 2,700 star images on six of these larger plates and had completed the preliminary reductions and part of the discussion by the end of the year.

Miscellaneous. Miss Pond has kept up to date the card-catalogue of stellar parallaxes, which forms the basis of the *General Catalogue* already issued and for such future editions of this compilation as may be demanded. She also prepared for the printer the tabular material for Volume 4, which was printed from her sheets (182 in number) by a photographic process.

Mr. Brown attended the meeting of the International Astronomical Union at Cambridge, England, in July, acting as chairman of the American delegation. Mr. Schlesinger also attended this meeting, arriving in England from South Africa.

The papers by Mr. Brown on the Trojan asteroids, on spiral nebulae, and on the lava oscillations in Kilauea, referred to in the report for last year, have been completed and published. His work on the eighth satellite of Jupiter has been laid aside during the year, owing to the pressure of other matters, principally those connected with the recent eclipse. An article on the latter of some sixty pages, entitled "A Celestial Encounter," has been published in Volume 2 of the *History of Connecticut* which has recently appeared. Much material on this subject previous to and after the eclipse was also written and printed in newspapers, magazines, and scientific journals.

The Total Eclipse of the Sun, January 24, 1925. Preparations for this event and the work of discussing some of the results of the observations have occupied a good deal of the energy of the staff during the year. Mr. Brown reports as follows: "During the whole of this month Mr. Stearns, the secretary, and the acting director were fully occupied in preparations for the eclipse. A program for the staff had been previously settled which was successfully carried out. Professor J. A. Miller, of Swarthmore, and Dr. H. D. Curtis, of Allegheny, had a large equipment on the grounds and a considerable staff for observation. Reverend Marsh, from Bermuda, and Mr. Worthington, from California, brought photographic telescopes, and a few others were given space for observing. A room was assigned to the American Telephone and Telegraph Company for their instruments and staff which maintained a telephone and telegraph circuit connecting the principal observatories in the zone of totality. Two film companies had representatives on the grounds, the old heliometer and its dome being assigned to one of them for use. All of these parties carried out their programs successfully. Acknowledgements have been made to the city and to the Boy Scouts for protecting the observers from interference. The Yale Observatory was the center of the unusual publicity which was given to the phenomenon."

In addition to carrying out successfully our own observations, Mr.

Brown, as chairman of a committee of the American Astronomical Society, had charge of a nation-wide campaign for informing the public concerning the eclipse and how best to observe it, as well as for securing from the general public certain data that needed great numbers of observers. It is planned to describe in detail the results of this eclipse work in the *Transactions* of the Observatory.

The Southern Telescope. The construction of the mounting, carried out in our own shop, was completed in October, 1924. The whole telescope was then set up in the Mason Mechanical Laboratory, which is admirably equipped for such operations. The telescope was then dismounted and packed for shipment, finally leaving New York early in February on the steamer *Western Glen* sailing direct for Capetown, where she arrived, much delayed, at the end of March. In the meantime, Mr. Schlesinger had sailed from New York to South Africa via Southampton, on December 27, taking the great lens with him as baggage. He reached Johannesburg on February 8. After considering several sites, he accepted the very generous invitation of the new University of the Witwatersrand, within the city limits. A fine plat of ground was put at our disposal by the University, which also agreed to certain restrictions as to their future building operations with a view to protecting our observatory from possible encroachments that might hamper its work; and furthermore, the University has erected, free of expense to Yale, a suitable office building with residence quarters for the astronomer in charge and for one assistant.

Ground was broken for the Observatory building on February 18; the construction was finished early in June. The building is brick, faced by artificial grey stone that conforms in general appearance with the University buildings close by. Owing to many unforeseen delays, the telescope could not be erected in the manner or sequence originally planned. It was put completely together on the floor of the Observatory building while the workmen were still constructing the walls, and then was lifted into place upon its great piers as a unit. It was a great satisfaction to rest it in its final position and to find that its fit and operation were right. This was done in the last week in May. Mr. Schlesinger remained in Johannesburg a month longer before turning the telescope over to Mr. Alden, who had arrived May 29, and who remains permanently in charge. During that month the mechanical and optical performance of the instrument was tested in every essential respect and was found to be satisfactory. Mr. O'Connell, who has had so large a share in the construction and erection of the telescope, remains with Mr. Alden as observing assistant.

FRANK SCHLESINGER, *Director.*

YERKES OBSERVATORY

UNIVERSITY OF CHICAGO

WILLIAMS BAY, WISCONSIN

Personnel. The Observatory suffered a great loss in the sudden death, on March 1, 1925, of John Adelbert Parkhurst, associate professor of practical astronomy, for 25 years a member of the staff.

Associate Professor Frank E. Ross took up his residence here on October 1 and began work with the Bruce telescope; somewhat later he commenced observing with the 40-inch refractor and 24-inch reflector.

Additions to the list of temporary computers during parts of the year were Miss Mary Howe, Miss Margrethe Jorgensen, and Mme. Ludwig Struve.

Mr. H. L. Vanderlinden, of the staff of the Royal Observatory of Belgium, having a fellowship of the C. R. B., was a guest of the University of Chicago at the Observatory from October 2, 1924, to June 3, 1925. He devoted his time chiefly to stellar photometry.

The following graduate students worked at the Observatory during the year. Summer Quarter of 1924: W. H. Garrett, E. M. Justin, and W. A. Luby; from October 1, through the academic year, N. T. Bobrovnikoff, who came to us from the University of Prague; and Miss A. V. Douglas, of McGill University, who began her summer's work on May 15, 1925.

Equipment. No notable additions were made to the equipment during the year under review.

Weather Conditions. The conditions for observations at night were unfavorable for nine out of the twelve months, as indicated in the following table. The departure is from our twenty-year normal and this is subject to the same reservations as last year.

HOURS OF OBSERVATION WITH 40-INCH TELESCOPE AT NIGHT.

	1924-25	Departure
July	122	—29
August	133	—23
September	160	+ 1
October	194	+24
November	122	—18
December	82	—50
January	129	—11
February	72	—57
March	100	—53
April	140	+20
May	101	—19
June	84	—42
	1439	—257

Except for preparations made for observing the total eclipse, the program continued as in the previous year.

Solar Work. With the Rumford spectroheliograph, Mr. Lee secured 113 satisfactory plates with an average of two exposures to the plate. Of these, 51 were of the disk and 62 were of the limbs. During his absence at Iron Mountain, Mr. Struve obtained seven spectroheliograms. Active prominences of considerable size were photographed rather fully with the spectroheliograph on April 2 and May 11, 1925, by Mr. Lee. He also observed visually with the "Scout" on numerous days.

A plan which has been under consideration for some years past was put into partial effect in that we prepared for the attachment to the 40-inch telescope of a Universal movie camera, kindly loaned to us by Dr. George S. Isham. Preliminary attempts were made with this by Mr. Lee to photograph the granulations of the solar disk. Negatives on film were made both in the focus of the 40-inch objective and with an amplifying lens giving fourfold enlargement. These observations can be profitably attempted only when the seeing is very fine.

With the 12-inch equatorial, 266 direct photographs of the sun on 154 days were obtained by Messrs. E. M. Justin and N. T. Bobrovnikoff. After extended experimenting, which has been in progress for some years, we adopted the plan of using a strip of green gelatin filter on the slit of the exposing shutter, Eastman process plates being employed. In this way, we are able to use the full aperture.

After the eclipse, Mr. Bobrovnikoff made some photographs of the chromosphere and prominences on dicyanine plates with the solar spectrograph adapted for the infra-red region.

Observations with the 40-inch Telescope. Micrometric. Mr. Van Biesbroeck made 776 measures of double stars, chiefly of those discovered by Hussey, on parts of 51 nights. The manuscript of observations of double stars by Mr. Van Biesbroeck since 1915 awaits only funds for printing. Hussey 1067=XY Persei was examined on 27 nights for determining the character of the change in brightness.

Faint comets were observed as follows, by Mr. Van Biesbroeck: 1924 *b*, Encke, 14 nights; 1924 *c*, Finsler, 2 n.; 1925 *a*, Shajn, 10 n.; 1925 *b*, Reid, 7 n.; 1925 *c*, Orkisz, 12 n.; and 1925 *d*, Tempel II, 4 n. Among observations of faint asteroids on parts of 27 other nights, may be mentioned those of Ganymede (1924 TD) on 18 nights, ending April 5. The satellite of Neptune was observed on 4 nights and those of Uranus on 3 nights. Mars was visually observed on favorable occasions and the south polar cap was measured on 20 nights. A bright extension to the terminator was followed for several hours on October 27.

Astrometric. Usable plates of 198 fields for parallax and proper motion have been taken with the 40-inch on parts of 51 nights by Mr. Lee, assisted by Mr. Sullivan. Twenty-two ordinary parallaxes have been derived by Mr. Lee, which are not yet published. A list of 33 parallaxes were given jointly by Mr. Van Biesbroeck and Mr. Lee in the *Astronomical Journal*, No. 840. Mr. Lee has published an inter-

pretation of trigonometric parallaxes derived in the mass, in *Astronomical Journal*, Nos. 847-848.

Photometric. The following observations were made by Mr. Parkhurst up to February 20, 1925, on parts of 21 nights. Seven plates were taken with the grating over the 40-inch objective, of which three were for photovisual magnitudes in the Rumford fields, one for polar sequence, and three for the star Bond 624 Orionis. The stellar photometer was used on four nights. One hundred thirteen visual observations of 32 variable stars were made on 13 nights.

Photographic. Experiments were made by Mr. Ross in photographing planets and double stars on Eastman kryptocyanine plates sensitive to wave-length 7600 A. He observed that the moon, Saturn, and Jupiter, show smaller diameters in the infra-red, as was found by Wright for Mars. Mr. Ross is carefully considering the photographic theory involved. Direct photographs of Mars with the enlarging lens employed by Mr. Barnard were occasionally made by Mr. Sullivan during the summer of 1924, but owing to the low altitude of the planet and poor weather conditions, these did not attain the excellence of the photographs secured in 1909 by Mr. Barnard.

Spectrographic. The Bruce spectrograph was used by Messrs. Barrett and Struve on 104 nights, the autocollimating spectrograph on one night. Mr. Sullivan assisted as usual. With a dispersion of one prism, 347 spectrograms were obtained, chiefly in completing the program on the B stars, with some A stars. With three prisms, 81 spectrograms were taken, some of them of the standard velocity stars, but the greater number were under a new program of repeating the observations of the twenty stars of the Orion type, observed and published over twenty years ago.

1034 plates were measured by Mr. Struve during the year, in completing the program of the B stars. In so doing, he found ten new spectroscopic binaries, and also found bright lines in certain stars, besides making a special study of a dark line near λ 4470. The orbits of 66 Eridani, by Messrs. Frost and Struve, and of 16 Lacertae, by Messrs. Struve and Bobrovnikoff, were published.

A model using threads was designed by Mr. Van Biesbroeck for computing the reduction to the sun and was found very satisfactory for checking computations to an accuracy of 0.1 km/sec.

Data for 14 unpublished spectroscopic binaries, discovered with the Bruce spectrograph by different workers, were communicated to the *Astrophysical Journal* by the director.

24-inch Reflector. On parts of 46 nights, 86 plates were secured for photometric purposes, including exposure ratio, polar sequence, and effective wave-lengths, 67 by Mr. Parkhurst, 14 by Miss Farnsworth, and 5 by Mr. Vanderlinden.

With this instrument faint comets were photographed for position and at times for physical appearance by Mr. Van Biesbroeck, who recovered Encke's comet and followed it through a rise from the 17th

to the 7th magnitude. Comets Finsler and Wolf were also photographed, the latter being one of the faintest ever observed. Asteroids of magnitude 13.8 and fainter continued to be observed by Messrs. Van Biesbroeck and Struve. Positions were obtained for 42 of these, and 3 new ones were discovered. Exposures made at the places predicted for 40 others failed to show them. Y. O. 21 proved to be (520) Franziska and Y. O. 23 to be (982) Franklina. The astrometric plates totaled 519.

The 12-inch Telescope was used chiefly for daily photographs of the sun, for the visual observation of prominences, and for general educational purposes.

The Bruce Photographic Telescope has been used by Mr. Ross since October 23, 1924. 45 fields were photographed with both the 10-inch and 6¼-inch lenses, with an average exposure of 2 hours. Mr. Ross devised a new procedure for avoiding error in focus due to variations in curvature of the plates as they came from the maker. The thickness of each plate is measured in the darkroom and a micrometer screw attached to the metallic plateholder forces the film into the correct plane. The plates were made for comparison under the blink-comparator, with plates taken by Mr. Barnard from 15 to 20 years earlier. Mr. Ross thus discovered 147 stars having proper motions greater than 0″.10 per year. For 57 of these, the proper motion exceeded 0″.50, and for 9, 1″.00. The largest found was 2″.55, the star being of about magnitude 10. The fields already covered by Max Wolf were avoided as far as known. From the data thus obtained, Mr. Ross estimates that there are 2,000 faint stars having an annual proper motion of 0″.50.

In the search for proper motions, 44 new variable stars were noted, 20 of them on one plate in a region in Sagittarius rich in variables. The minimum of light is in general below magnitude 15, so that the 40-inch telescope is required for following the variation visually.

The Zeiss U.-V. Doublet was used on 27 nights during the summer of 1924, by Mr. Garrett, for determining the color of planetary nebulae, with and without a color-filter, by the method of exposure ratio. With the objective-prism, Mr. Parkhurst obtained two plates of Comet Finsler, and Mr. Bobrovnikoff secured 13 of Comet Orkisz and 3 of Comet Tempel II.

Miss Douglas made experiments, with the objective-prism over the Tessar lens of the *Sky Patrol,* in an attempt to secure comparison lines from absorption spectra, but nothing was found equal to neodymium for this purpose.

With the *Comet-Seeker,* Mr. W. R. Paul, of Chicago, observed on ten clear, and seven partly clear nights, making eleven trips to the Observatory. He swept the entire heavens visible in this latitude.

Plans had been made for observing the solar eclipse of January 24, 1925, by a small expedition to Iron Mountain, Michigan, by Messrs. Ross and Lee, with whom were associated Mr. F. D. Urie of the Elgin Observatory and Director S. A. Barrett of the Milwaukee Public

Museum. The sky was entirely cloudy there. Mr. Parkhurst took the Hartmann surface photometer, suitably adapted for the purpose, to Ithaca, New York, where he successfully observed the intensity of the total light of the corona. Mr. Blakslee used a Universal moving camera at Binghamton, New York, but did not obtain a successful film. Plans had been made to observe the red and infra-red flash spectrum on kryptocyanine plates with the Bruce spectrograph attached to the 40-inch telescope, with the solar spectrograph on the 12-inch telescope, and with a small concave grating on the mounting of the 24-inch reflector. Had the sky been clear, we should have had a much longer time for the observation of the flash spectrum than would have been possible in the track of totality.

Part IV of Volume III of the *Publications of the Yerkes Observatory*, containing Mr. Pettit's paper on the solar prominences and completing the volume, was issued and distributed during the year. Progress was made in the preparation for publication of Mr. Barnard's *Atlas of Selected Regions of the Milky Way*, by Miss Calvert, under the supervision of the director; and in the reduction of Mr. Barnard's observations of the globular clusters by the Misses Calvert and Jorgensen, with the oversight of Mr. Van Biesbroeck.

The Library. 249 bound and 24 unbound books were added to the library, as well as 300 pamphlets. Reprints of many of Mr. Barnard's papers are available for distribution to workers who may wish them.

Visitors to the number of 13,565 were recorded, chiefly on the public Saturday afternoons.

EDWIN B. FROST, *Director.*

PLANET NOTES FOR MARCH.

The *Sun's* path for the month of March will lie in a northeasterly direction from the constellation Aquarius into the constellation Pisces. It will be in a region of the sky in which there are no conspicuous bright stars. Its position on March 1 will be in right ascension $22^h\ 45^m$; in declination $-7°\ 57'$; on March 31 in right ascension $0^h\ 35^m$; in declination $+3°\ 47'$. It will cross the equator on March 21, at 3:00 A.M. C.S.T. This event marks the time of the vernal equinox, and is the calendar date for the beginning of spring. The distance between the sun and the earth will be increasing during this month, and at the end it will be practically the average for the year.

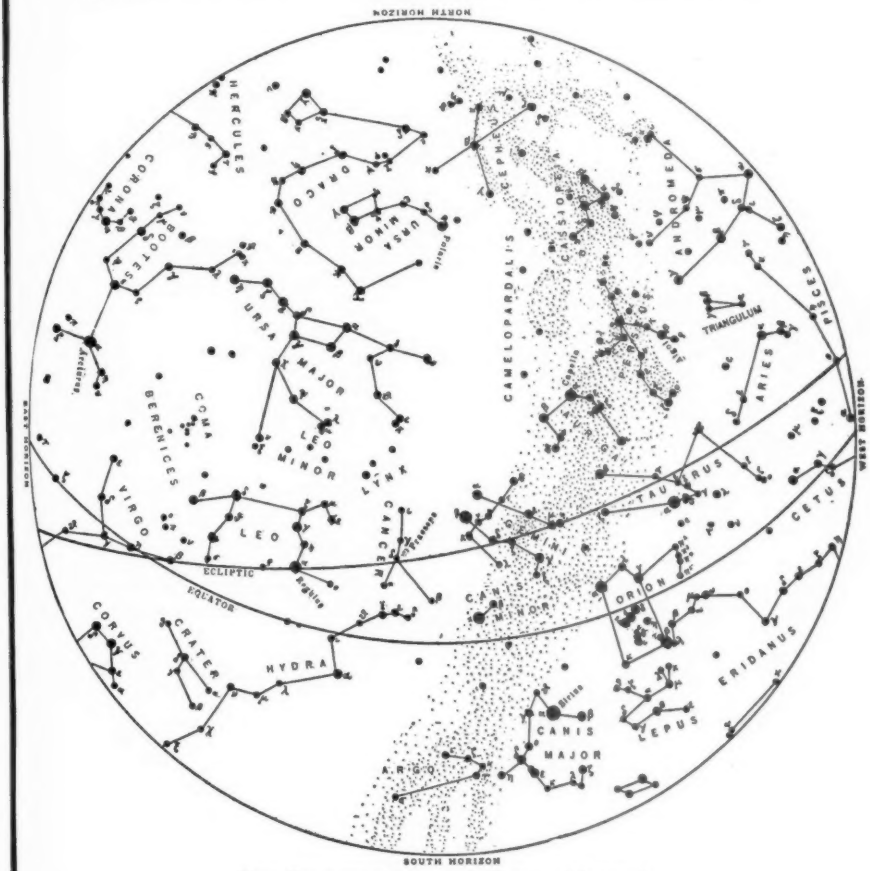
The phases of the *Moon* will occur as follows:

Last Quarter	March 11	at	6 A.M.	C.S.T.
New Moon	13	"	10 P.M.	"
First Quarter	20	"	11 P.M.	"
Full Moon	29	"	4 A.M.	"

The moon will be farthest from the earth on March 25, and nearest the earth on March 13.

Mercury will be at a point of greatest elongation east of the sun on March 14. This will be a favorable time to watch for the appearance of this planet in the evening sky. It will be about 7° north of the sun and will set more than an hour

after the sun. Therefore on or near this date, if one has a clear sky and an unobstructed horizon, it will merely be necessary to note the point on the horizon at which the sun disappears and then scan the sky a short distance to the north of this point. The planet will be bright enough to be seen in the twilight before it sets. After this it will move westward toward the sun and will be at inferior conjunction on March 31. At this time it will be in the constellation Pisces.



THE CONSTELLATIONS AT 9:00 P.M. MARCH 1.

Venus will be west of the sun and will be moving eastward rather slowly during this month. Its distance west of the sun will therefore be increasing. At the end of the month it will be approaching a point of greatest elongation west of the sun and will cross the meridian soon after 9:00 o'clock in the morning. It will be at a period of greatest brilliancy on March 14, and consequently will be the conspicuous morning star. It will be between 11° and 12° south of the equator.

Mars will be well situated for morning observations during March. It will cross the meridian between 8:00 and 9:00 A. M. It will however be 22° south of the equator. It will be nearly two astronomical units distant, and will therefore not be very bright.

Jupiter will be between two and three hours west of the sun; it will be in the morning sky during March. It will be in the same general region of the sky as Venus.

Saturn will be on the meridian at 4:00 A. M. on the average during March. It too will be south of the equator.

Uranus will be in conjunction with the sun on March 16, and will therefore be invisible during this month.

Neptune will be near the meridian at midnight, and will therefore be in a position to be observed nearly all night during the month of March.

Occultations Visible at Washington.

[From the *American Ephemeris.*]

Date 1926	Star's Name	Magnitude	IMMERSION. Washington C.T. h m	IMMERSION. Angle from N °	EMERSION. Washington C.T. h m	EMERSION. Angle from N °	Duration h m
Mar. 3	80 Virginis	5.6	3 38	179	4 26	246	0 48
7	109 B. Ophiuchi	6.2	5 44	104	7 10	283	1 26
9	168 B. Sagittarii	6.3	4 18	143	5 7	230	0 48
25	12 B. Leonis	6.3	0 33	161	1 22	244	0 49

Saturn's Satellites.

[From the *American Ephemeris.*]

CENTRAL STANDARD TIME, MIDNIGHT = 0^h

I. Mimas. Period 0^d 22^h6.

1926	d	h		d	h		d	h		d	h	
Mar.	1	0.3	E	Mar. 9	23.1	W	Mar. 17	23.3	E	Mar. 26	22.2	W
	4	7.4	W	12	7.7	E	21	6.5	W	29	6.8	E
	5	6.1	W	13	6.3	E	22	5.1	W	30	5.4	E
	6	4.7	W	14	4.9	E	23	3.7	W	31	4.0	E
	7	3.3	W	15	3.5	E	24	2.3	W			
	8	1.9	W	16	2.1	E	25	1.0	W			
	9	0.5	W	17	0.7	E	25	23.6	W			

II. Enceladus. Period 1^d 8^h9.

Mar.	1	17.3	E	Mar. 9	22.6	E	Mar. 18	3.8	E	Mar. 26	9.1	E
	3	6.2	E	11	7.5	E	19	12.7	E	27	18.0	E
	4	11.1	E	12	16.4	E	20	21.6	E	29	2.8	E
	5	19.9	E	14	1.2	E	22	6.5	E	30	11.7	E
	7	4.8	E	15	10.1	E	23	15.3	E			
	8	13.7	E	16	19.0	E	25	0.2	E			

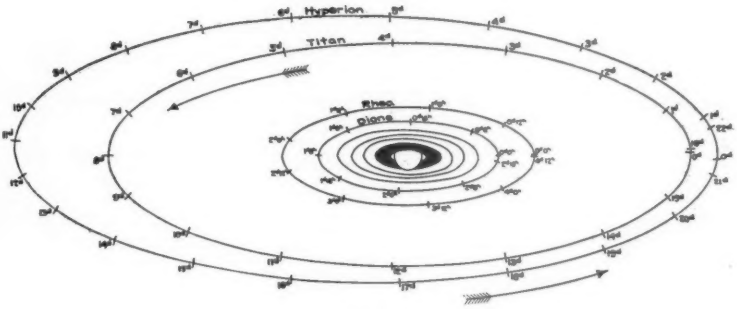
III. Tethys. Period 1^d 21^h3.

Mar.	1	4.9	E	Mar. 8	18.1	E	Mar. 16	7.3	E	Mar. 23	20.5	E
	3	2.2	E	10	15.4	E	18	4.6	E	25	17.8	E
	4	23.5	E	12	12.7	E	20	1.9	E	27	15.1	E
	6	20.8	E	14	10.0	E	21	23.2	E	29	12.4	E
										31	9.7	E

IV. Dione. Period 2^d 17^h7.

Mar.	0	21.1	E	Mar. 9	2.2	E	Mar. 17	7.2	E	Mar. 25	12.2	E
	3	14.8	E	11	19.8	E	20	0.9	E	28	5.9	E
	6	8.5	E	14	13.5	E	22	18.6	E	30	23.6	E

South



North

Apparent orbits of the seven inner satellites of Saturn at date of opposition, May 14, 1926, as seen in an inverting telescope.

V. Rhea. Period $4^d\ 12^h5$.

1926	d	h		d	h	1926	d	h		d	h
Mar.	2	14.7 E	Mar.	11	15.5 E	Mar.	20	16.3 E	Mar.	29	17.0 E
	7	3.1 E		16	3.9 E		25	4.7 E			

VI. Titan. Period $15^d\ 23^h3$.

Mar.	6	23.4 W	Mar.	14	19.3 E	Mar.	22	21.8 W	Mar.	30	17.5 E

VII. Hyperion. Period $21^d\ 7^h6$.

Mar.	6	9.8 E	Mar.	17	17.5 W	Mar.	27	14.9 E			

VIII. Japetus. Period $79^d\ 22^h1$.

			Mar.	2	18.5 S	Mar.	22	8.0 E			

NOTE—E, Eastern Elongation; W, Western Elongation; S, Superior Conjunction; I, Inferior Conjunction.

VARIABLE STARS.

SU Tauri and U Geminorum.—According to a communication from L. C. Peltier of Delphos, Ohio, SU Tauri, 054319, is again decreasing in brightness. On December 4 it was at full brightness, magnitude 9.6; on December 9 it had reached magnitude 10.5, and on December 18 it had further decreased to magnitude 12.4. It is only 460 days since the last drop to minimum, the star having remained at maximum 250 days. This interval is in marked contrast to the interval of 2855 days between the previous minima, when the star remained at maximum for more than seven years (2750 days).

Messrs. Bouton and Dunham observed U Geminorum, 074922, increasing on December 5, magnitude 13. The maximum was of the short, narrow type, occupying only seven days in passing from magnitude 12 through maximum at magnitude 9, and back to magnitude 12.

Harvard College Observatory Bulletin 830.
Cambridge, Massachusetts, December 29, 1925.

Minima of Variable Stars of Short Period.

[Calculated by members of the classes in Astronomy at Carleton College.]

Given to the nearest hour in Greenwich civil time; to obtain Eastern Standard time subtract 5h; Central Standard time 6h, etc.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich civil times of minima in 1926 March					
	h m	° ′		d h	d h	d h	d h	d h	d h	d h
SY Androm.	0 08.0	+43 09	9.5—13.0	34 21.8					29	3
RT Sculptor.	31.5	—26 13	9.6—10.5	0 12.3	4 16	12 8	20 1		27	17
U Cephei	0 53.4	+81 20	7.0— 9.0	1 11.8	5 19	13 4	20 16		28	3
Z Persei	2 33.7	+41 46	9.4—12	3 01.4	5 10	11 23	17 15		29	21
TW Cassiop.	37.6	+65 19	8.2— 9.0	1 10.3	9 18	18 8	26 22			
RY Persei	39.0	+47 43	8.0—10.3	6 20.7	2 16	9 12	23 6		30	3
RZ Cassiop.	39.9	+69 13	6.9— 8.1	1 04.7	6 5	13 9	20 13		27	18
TX Cassiop.	44.4	+62 22	9.4—10.1	2 22.2	4 6	13 1	21 20		30	15
ST Persei	53.7	+38 47	8.5—10.5	2 15.6	7 0	14 23	22 22		30	20
RX Cassiop.	2 58.8	+67 11	8.6— 9.1	32 07.6	8 16					
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8	3 16	12 6	20 21		29	11
RT Persei	16.7	+46 12	9.5—11.5	0 20.4	7 18	14 13	21 8		28	3
λ Tauri	55.1	+12 12	3.3— 4.2	3 22.9	7 18	15 16	23 13		31	11
RW Tauri	3 57.8	+27 51	7.1— [11	2 18.5	3 1	11 8	19 16		27	23
RV Persei	4 04.2	+33 59	9.5—11.0	1 23.4	7 2	14 23	22 21		30	19
RW Persei	13.3	+42 04	8.8—11.0	13 04.8		10 10	23 15			
SZ Tauri	31.4	+18 20	7.2— 7.7	3 03.6	2 12	8 19	21 9		27	16
RS Cephei	4 48.6	+80 06	9.5—12.0	12 10.1	5 19	18 7	30 15			
TT Aurigae	5 02.8	+39 27	7.8— 8.7	0 16.0	4 20	11 12	18 4		24	20
RY Aurigae	11.5	+38 13	10.7—11.7	2 17.5	9 3	17 7	21 9		25	11
RZ Aurigae	42.9	+31 40	10.6—13.3	3 00.3	1 21	7 21	19 22		31	23
SV Tauri	45.8	+28 05	9.4—11.0	2 04.0	2 19	11 11	20 3		28	19
Z Orionis	50.2	+13 40	9.7—10.7	5 04.9	2 1	12 11	22 21			
SV Gemin.	54.6	+24 28	9.8— [11	4 00.2	8 21	16 22	24 22			
RW Gemin.	5 55.4	+23 08	9.5—11.0	2 20.8	3 15	9 9	20 20		26	13
U Columbæ	6 11.2	—33 03	9.2—10.0	2 19.2	2 22	14 3	19 17		30	22
SX Gemin.	22.0	+20 37	10.8—11.5	1 08.8	6 11	14 16	22 21		31	2
RW Monoc.	29.3	+ 8 54	9.0—10.8	1 21.7	6 6	13 21	21 12		29	3
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0		12 14	24 19			
RU Monoc.	6 49.4	— 7 28	9.8—10.5	0 21.5	2 6	9 10	23 18		30	22
R Can. Maj.	7 14.9	—16 12	5.8— 6.4	1 03.3	9 18	16 14	23 9		30	5
RY Gemin.	21.7	+15 52	8.9— [10	9 07.2	6 23	16 7	25 14			
Y Camelop.	27.6	+76 17	9.5—12	3 07.3	9 2	15 17	22 8		28	
TX Gemin.	30.3	+17 08	10.0—11.9	2 19.2	3 6	11 15	20 1		28	11
RR Puppis	43.5	—41 08	9.4—10.7	6 10.3	2 2	8 13	21 9		27	20
V Puppis	7 55.4	—48 58	4.1— 4.8	1 10.9	2 15	9 21	24 11		31	17
X Carinae	8 29.1	—58 53	7.9— 8.7	0 13.0	3 14	11 17	19 20		27	23
S Cancri	8 38.2	+19 24	8.2—10	9 11.6	4 19	14 6	23 18			
RX Hydrae	9 00.8	— 7 52	9.1—10.5	2 06.8	2 8	9 4	22 21		29	17
S Velorum	29.4	—44 46	7.8— 9.3	5 22.4	5 16	11 14	23 11		29	9
Y Leonis	9 31.1	+26 41	9.3—11.2	1 16.5	1 18	8 12	21 23		28	17
RR Velorum	10 17.8	—41 36	10.0—10.9	1 20.5	3 16	11 2	18 12		25	22
SS Carinæ	10 54.2	—61 23	12.2—12.8	3 07.2	3 5	9 20	23 1		29	15
ST Urs. Maj.	11 22.4	+45 44	6.7— 7.2	8 19.2	8 3	16 23	25 17			
RW Urs. Maj.	35.4	+52 34	10.3—11.4	7 07.9	4 11	11 15	19 4		26	11
Z Draconis	11 39.8	+72 49	9.9—13.6	1 08.6	3 23	10 18	24 8		31	3
RZ Centauri	12 55.6	—64 05	8.5— 8.9	1 21.0	1 13	9 1	24 2		31	14
RS Can. Ven.	13 06.3	+36 28	7.5—12 5	4 19.1	2 20	12 11	22 1		31	15
SS Centauri	07.2	—63 37	8.8—10.4	2 11.5	5 15	13 1	20 12		27	23
SX Hydræ	13 39.0	—26 23	8.6—12.7	2 21 5	3 16	9 11	21 1		26	20

Minima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich civil times of minima in 1926 March							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
δ Libræ	14 55.6	— 8 07	4.8— 6.2	2 07.9	2 9	9 9	23 8	30 8				
U Coronæ	15 14.1	+32 01	7.6— 8.7	3 10.9	3 3	10 0	23 20	30 17				
TW Draconis	15 32.4	+64 14	7.3— 8.9	2 19.4	1 2	9 13	17 23	26 9				
SS Libræ	15 43.4	—15 14	9.3—11.5	0 18.4	5 2	12 7	19 11	26 16				
SW Ophiuchi	16 11.1	— 6 44	9.2—10.0	2 10.7	2 5	9 13	24 5	31 13				
SX Ophiuchi	12.6	— 6 25	10.5—11.2	2 01.5	2 8	10 14	18 20	27 2				
R Aræ	31.1	—56 48	6.8— 7.9	4 10.2	9 1	17 21	26 17					
TT Herculis	16 49.9	+17 00	8.9— 9.3	20 18.1		12 17						
TU Herculis	17 09.8	+30 50	9.5—12	2 06.4	1 20	8 15	22 6	29 1				
U Ophiuchi	11.5	+ 1 19	6.0— 6.7	0 20.1	3 22	12 7	20 17	29 2				
u Herculis	13.6	+33 12	4.6— 5.4	2 01.2	3 23	10 2	22 9	28 13				
TX Herculis	15.4	+42 00	8.3— 9.0	1 00.7	1 17	7 21	20 6	26 10				
RV Ophiuchi	29.8	+ 7 19	9. —12	3 16.5	5 11	12 20	20 5	27 14				
SZ Herculis	36.0	+33 01	9.5—10.3	0 19.6	8 9	16 14	24 18					
TX Scorpii	48.6	—34 13	7.5— 8.2	0 22.6	4 7	11 20	19 9	26 22				
UX Herculis	49.7	+16 57	8.8—10.5	1 13.2	1 4	8 22	16 16	24 10				
Z Herculis	53.6	+15 09	7.1— 7.9	3 23.8	7 2	15 2	23 2	31 1				
WX Sagittarii	53.6	—17 24	9.2—10.8	2 03.1	5 21	14 9	22 22	31 10				
WY Sagittarii	17 54.9	—23 01	9.5—10.6	4 16.0	2 18	12 2	21 11	30 19				
SX Draconis	18 03.0	+58 23	9.3—10.5	5 04.1	7 2	12 6	22 14	27 18				
RS Sagittarii	11.0	—34 08	5.9— 6.3	2 10.0	5 3	12 9	19 15	26 21				
V Serpentis	11.1	—15 34	9.5—11.1	3 10.9	1 21	8 18	22 14	29 12				
RZ Scuti	21.1	— 9 15	7.4— 8.3	15 03.2		13 1		28 5				
RZ Draconis	21.8	+58 50	9.5—10.2	0 13.2	5 16	12 20	20 1	27 4				
RX Herculis	26.0	+12 32	7.0— 7.6	0 21.3	7 4	14 7	21 10	28 12				
SX Sagittarii	39.7	—30 36	8.7— 9.8	2 01.8	3 11	11 18	20 1	28 9				
RR Draconis	40.8	+62 34	9.3—13	2 19.9	2 17	11 5	19 17	28 5				
RS Scuti	43.7	—10 21	9.3—10.3	0 15.9	4 18	11 10	24 17	31 8				
β Lyræ	46.4	+33 15	3.4— 4.1	12 21.8		12 20		25 18				
U Scuti	18 48.9	—12 44	9.1— 9.6	0 22.9	2 8	9 23	17 15	25 6				
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.4	4 14	12 4	19 18	27 8				
RV Lyræ	12.5	+32 15	11. —12.8	3 14.4	2 3	9 8	23 18	30 23				
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4	8 7	17 6	26 5					
U Sagittæ	14.4	+19 26	6.5— 9.0	3 09.1	3 9	10 3	23 16	30 10				
Z Vulpec.	17.5	+25 23	7.3— 8.5	2 10.9	5 5	12 14	19 22	27 7				
TT Lyræ	24.3	+41 30	9.4—11.6	5 05.8	3 18	14 6	19 12	30 0				
UZ Draconis	26.1	+68 44	9.0— 9.8	1 15.1	2 14	9 3	22 4	28 16				
SY Cygni	19 42.7	+32 28	10. —12	6 00.2	3 8	9 9	21 9	27 9				
WW Cygni	20 00.6	+41 18	9.3—13.4	3 07.6	1 1	7 16	20 23	27 14				
SW Cygni	03.8	+46 01	9. —11.7	4 13.8	2 24	12 3	21 7	30 10				
VW Cygni	11.4	+34 12	9.8—11.8	8 10.3	2 3	10 13	19 0	27 10				
RW Capric.	12.2	—17 59	8.8—10.6	3 09.4	1 4	7 23	21 12	28 7				
UW Cygni	19.6	+42 55	10.5—13	3 10.8	1 20	8 18	22 13	29 11				
V Vulpec.	32.3	+26 15	8.2— 9.8	37 19.0								
W Delphini	33.1	+17 56	9.4—12.1	4 19.4	5 14	15 5	20 0	29 15				
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4	6 21	16 1	25 6					
Y Cygni	48.1	+34 17	7.1— 7.9	1 12.0	7 8	16 7	25 7					
WZ Cygni	49.3	+38 27	9.9—10.8	0 14.0	7 11	15 0	22 16	30 6				
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2		11 20	21 23					
RY Aquarii	21 14.8	—11 14	8.8—10.4	1 23.2	4 23	12 20	20 17	28 14				
UZ Cygni	55.2	+43 52	8.9—11.6	31 07.3				28 14				
RT Lacertæ	21 57.4	+43 24	9.1—10.5	5 01.7	3 18	13 21	18 23	29 2				
RW Lacertæ	22 40.6	+49 08	10.2—11.2	5 04.4	4 1	14 10	19 14	29 23				
VW Pegasi	51.7	+32 42	10.0—10.6	5 06.4	5 2	15 14	20 21	31 10				
Y Piscium	23 29.3	+ 7 22	9.0—12.0	3 18.4	5 20	13 9	20 22	28 11				
TW Androm.	23 58.2	+32 17	8.6—11.5	4 02.9	3 22	12 3	20 9	27 15				

Maxima of Variable Stars of Short Period.

[Calculated by members of the classes in Astronomy at Carleton College.]

Given to the nearest hour in Greenwich civil time; to obtain Eastern Standard time subtract 5h; Central Standard time 6h, etc.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich civil times of maxima in 1926 March							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
SX Cassiop.	0 05.5	+54 20	8.6— 9.2	36 13.7							29	20
SY Cassiop.	0 09.8	+57 52	9.3— 9.9	4 01.7	5	9	13	13	21	16	29	19
RR Ceti	1 27.0	+ 0 50	8.3— 9.0	0 13.3	2	8	10	2	17	20	25	14
RW Cassiop.	1 30.7	+57 15	8.9—11.0	14 19.2	6	10			21	5		
V Arietis	2 09.6	+11 46	8.3— 9.0	0 23.8	2	19	10	18	18	17	26	15
SU Cassiop.	2 43.0	+68 28	6.5— 7.0	1 22.8	3	18	11	13	19	8	27	3
RW Camelop.	3 46.2	+58 21	8.2— 9.4	16 00.0	7	17			24	3		
SX Persei	4 10.2	+41 27	10.4—11.2	4 07.0	6	9	14	23	22	13	26	20
SV Persei	42.8	+42 07	8.8— 9.6	11 03.1			11	8	22	11		
RX Aurigæ	4 54.5	+39 49	7.2— 8.1	11 15.0	7	15	19	6	30	21		
SX Aurigæ	5 04.6	+42 02	8.0— 8.7	1 12.8	3	19	11	11	19	2	26	18
SY Aurigæ	05.5	+42 41	8.4— 9.5	10 03.3			10	7	20	11	30	13
Y Aurigæ	21.5	+42 21	8.6— 9.6	3 20.6	4	11	8	8	16	1	23	18
RZ Gemin.	5 56.6	+22 15	9.1—10.0	5 12.7	3	16	14	17	20	6	31	7
RS Orionis	6 16.5	+14 44	8.2— 8.9	7 13.6	3	1	10	15	18	4	25	18
T Monoc.	19.8	+ 7 08	5.7— 6.8	27 00.3					23	7		
RT Aurigæ	23.0	+30 33	5.1— 6.0	3 17.5	2	21	10	8	17	19	25	6
W Gemin.	29.2	+15 24	6.7— 7.5	7 22.0	3	20	11	18	19	16	27	17
ξ Gemin.	6 58.2	+20 43	3.7— 4.3	10 03.7	5	2	15	5	23	9		
RU Camelop.	7 10.9	+69 51	8.5— 9.8	22 06.5			16	0				
RR Gemin.	7 15.2	+31 04	10.0—11.5	0 09.5	3	20	11	19	19	18	27	17
V Carinae	8 26.7	—59 47	7.4— 8.1	6 16.7	6	4	12	21	19	14	26	7
T Velorum	8 34.4	—47 01	7.6— 8.5	4 15.3	5	1	14	8	18	23	28	5
V Velorum	9 19.2	—55 32	7.5— 8.2	4 08.9	1	22	10	16	19	10	28	4
Z Leonis	9 46.4	+27 22	7.9— 9.6	56 08.7							23	6
RR Leonis	10 02.1	+24 29	9.1—10.1	0 10.9	1	4	7	22	21	12	28	7
SU Draconis	11 32.2	+67 53	8.9— 9.6	0 15.8	1	4	7	19	21	0	27	14
S Muscae	12 07.4	—69 36	6.4— 7.3	9 15.8	5	11	15	3	24	18		
SW Draconis	12.8	+70 04	8 8— 9.6	0 13.7	3	22	11	21	19	21	27	20
T Crucis	15.9	—61 44	6.8— 7.6	6 17.6	6	20	13	14	20	7	27	0
R Crucis	18.1	—61 04	6.8— 7.9	5 19.8	5	15	11	11	23	3	28	23
S Crucis	12 48.4	—57 53	6.5— 7.6	4 16.6	1	1	10	10	19	19	29	4
W Virginis	13 20.9	— 2 52	8.7—10.4	17 06.5			16	6				
SS Hydræ	25.0	—23 08	7 4— 8.1	8 04.8	3	23	11	2	19	7	27	12
RV Urs. Maj.	13 29.4	+54 31	9.2— 9.9	0 11.2	5	22	12	22	19	23	26	23
ST Virginis	14 22.5	— 0 27	10.3—11.4	0 09.9	7	9	14	19	22	5	29	14
V Centauri	25.4	—56 27	6.4— 7.8	5 11.9	5	0	10	11	21	11	26	23
R3 Bootis	29.3	+32 11	8.9—10.0	0 09 1	1	2	8	15	23	17	31	6
R Triang.Austr.	15 10.8	—66 08	6.7— 7.4	3 09.3	4	23	11	17	18	12	25	7
S Triang.Austr.	15 52.2	—63 29	6.4— 7.4	6 07.8	3	3	9	10	22	2	28	10
S Normæ	16 10.6	—57 39	6.6— 7.6	9 18 1	2	16	12	10	22	4	31	22
RW Draconis	33.7	+58 03	9.6—10.8	0 10.6	8	9	17	6	26	2		
RV Scorpii	16 51.8	—33 27	6.7— 7.4	6 01.5	5	14	11	15	23	18	29	20
X Sagittarii	17 41.3	—27 48	4.4— 5.0	7 00.3	2	13	9	14	23	14	30	15
Y Ophiuchi	47.3	— 6 07	6.1— 6.5	17 02 9	7	18			24	21		
W Sagittarii	17 58.6	—29 35	4.3— 5.1	7 14.3	3	2	10	17	18	7	25	21
Y Sagittarii	18 15.5	—18 54	5.4— 6.2	5 18.6	5	6	11	0	22	13	28	8
U Sagittarii	26.0	—19 12	6.5— 7.3	6 17.9	5	16	12	10	19	4	25	22
Y Scuti	32.6	— 8 27	8.7— 9.2	10 08 3	10	0	20	9	30	17		
RZ Lyræ	39.9	+32 42	9.9—11.2	0 12.3	3	9	11	1	18	17	26	9
RT Scuti	18 44.1	—10 30	9.1— 9.7	0 11.9	1	20	9	7	24	4	31	14
κ Pavonis	18 46.6	—67 22	3.8— 5.2	9 02.2	1	4	10	6	19	9	28	11
U Aquilæ	19 24.0	— 7 15	6.2— 6.9	7 00.6	1	19	8	19	22	21	29	21

Maxima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich civil times of maxima in 1926 March							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
XZ Cygni	19 30.4	+56 10	8.6— 9.3	0 11.2	8 5	15 5	22 5	29 5				
U Vulpec.	32.2	+20 07	6.5 - 7.6	7 23.5	7 18	15 18	23 17	31 17				
SU Cygni	40.8	+29 01	6.2— 7.0	3 20.3	3 19	11 11	19 4	26 21				
η Aquilæ	47.4	+ 0 45	3.7— 4.5	7 04.2	5 10	12 14	19 18	26 23				
S Sagittæ	51.5	+16 22	5.6— 6.4	8 09.2	6 22	15 7	23 16					
X Vulpec.	19 53.3	+26 17	9.5—10.5	6 07.7	4 18	11 2	23 17	30 1				
X Cygni	20 39.5	+35 14	6.0— 7.0	16 09.3	2 14		18 23					
T Vulpec.	47.2	+27 52	5.5— 6.1	4 10.5	4 23	13 20	22 16	31 13				
UY Cygni	52.3	+30 03	9.6—10.4	0 13.5	3 10	10 17	18 0	25 7				
RV Capric.	55.9	—15 37	9.2—10.1	0 10.7	7 20	15 0	22 4	29 8				
TX Cygni	20 56.4	+42 12	8.5— 9.7	14 17.4		11 18		26 9				
VY Cygni	21 00.4	+39 34	8.8— 9.5	7 20.6	1 12	9 9	17 6	25 2				
SW Aquarii	10.2	— 0 20	9.9—10.8	0 11.0	5 16	12 13	19 10	26 7				
VZ Cygni	21 47.7	+42 40	8.2— 9.2	4 20.7	2 3	11 20	21 14	31 7				
Y Lacertæ	22 05.2	+50 33	9.1— 9.6	4 07.8	5 4	13 19	22 11	31 3				
δ Cephei	25.5	+57 54	3.7— 4.6	5 08.8	1 3	11 20	17 5	27 23				
Z Lacertæ	36.9	+56 18	8.2— 9.0	10 21.1		10 19	21 17					
RR Lacertæ	37.5	+55 55	8.5— 9.2	6 10.1	2 5	8 16	21 11	27 21				
V Lacertæ	44.5	+55 48	8.5— 9.5	4 23.6	5 20	15 19	20 19	30 18				
X Lacertæ	22 45.0	+55 54	8.2— 8.6	5 10.7	5 6	10 17	21 14	27 1				
SW Cassiop.	23 03.7	+58 11	9 2— 9.7	5 10.6	2 1	12 23	18 9	29 6				
RS Cassiop	32.6	+61 52	9.0—11.0	6 07.1	5 19	12 3	24 17	31 0				
RY Cassiop.	47.2	+58 11	9.3—11.8	12 03.4		12 22		25 1				
V Cephei	23 51.7	+82 38	6.0— 7.0	0 23.9	7 24	14 23	21 23	28 22				

Monthly Report of the American Association of Variable Star Observers, December 1925.

Although the poor observing conditions which prevailed during December resulted in fewer observations being reported, it is interesting to note that the average number of variables observed was well maintained.

SU Tauri has been in the lime-light again, starting on its downward plunge to minimum early in December. At the present time it has passed well below the 13th magnitude. The interval since the last drop to minimum was only a year and a half, while that between the previous minima was seven years, according to the AAVSO observations.

Both SS Aurigae and U Geminorum have been at maximum recently, the former late in November, and the latter, early in December. The completeness with which these irregular variables are being observed well warrants the existence of the AAVSO, not to mention the several hundred long period variables which are being so regularly observed.

Mr. Rhorer of Atlanta, Ga., has opened up his fourth season at Miami, Fla., with another 5-inch telescope, where he will give the "Man of the Street" a further opportunity to learn more of the wonders of the sky. Messrs. Olcott and Elmer will lend a helping hand in this praiseworthy enterprise.

Mr. D. P. Pickering, Patron, Life Member and First President of our Association, will spend the greater portion of the year travelling through Europe. Mr. Pickering has been appointed official representative of the Association while abroad, since he intends to visit many of our European members and foreign observatories. "Variable Comments" will doubtless contain a vivid account of his experiences after his return home.

VARIABLE STAR OBSERVATIONS RECEIVED DURING DECEMBER, 1925.

Oct. 0 = J. D. 2424424 Nov. 0 = J. D. 2424455 Dec. 0 = J. D. 2424485

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
000339 V SCULPTORIS—						
	4449.0	[13.0	Bl			
001032 S SCULPTORIS—						
	4448.9	7.6	Bl	4469.0	6 9	Kd
	4460.0	7.2	Kd	4477.0	6.8	Kd
	4461.0	7.1	Kd	4495.6	7.0	Pt
	4462.0	7.0	Kd			
001046 X ANDROMEDAE—						
	4474.7	11.9	Lv	4479.5	11.3	B
	4475.6	11.7	Wf	4489.5	11.8	B
	4478.6	11.7	Ie			
001629 T CETI—						
	4458.0	6.3	Kd	4469.9	6.3	Kd
	4461.9	6.3	Kd	4475.4	6.5	L
	4463.4	6.9	L	4476.0	6.3	Kd
001726 T ANDROMEDAE—						
	4474.6	11.7	Lv	4495.6	12 3	Pt
	4489.5	12.0	B			
001755 T CASSIOPEIAE—						
	4458.2	9.4	L	4489.5	8.9	B
	4469.1	9.8	Ch	4491.6	8.4	Jo
	4475.3	8.9	L	4492.5	9.2	Ie
	4478.5	8 7	B	4495.6	8.5	Pt
	4481.5	9.0	B	4495.6	8.8	Al
	4484.7	8.8	L	4498.7	8.4	Jo
001838 R ANDROMEDAE—						
	4387.7	10.8	Cy	4470.0	[11.6	Ch
	4465.8	13.1	Cy	4475.6	13.6	Wf
	4477.8	[12.4	Cy	4495.6	[13.0	B
	4495.8	[12.4	Cy	4495.6	14.1	Pt
001862 S TUCANAE—						
	4448.9	[12.5	Bl			
001909 S CETI—						
	4470.0	11.6	Ch	4495.6	12.6	Pt
	4475.3	11.7	L			
002546 T PHOENICIS—						
	4448.9	8.5	Bl			
003179 Y CEPHEI—						
	4477.7	8.7	Ch	4479.4	9.3	B
004047 U CASSIOPEIAE—						
	4474.7	12.7	Lv	4481.5	12.6	B
	4475.6	12.6	Wf	4495.6	13.5	Pt
004132 RW ANDROMEDAE—						
	4470.0	[11.0	Ch			
004435 V ANDROMEDAE—						
	4474.7	10.3	Lv			
004435 X SCULPTORIS—						
	4448.9	10.3	Bl			
004533 RR ANDROMEDAE—						
	4475.6	13.0	Wf	4489.5	13.3	B
004746a RV CASSIOPEIAE—						
	4475.6	12.0	Wf	4495.6	13.0	Pt
004746b — CASSIOPEIAE—						
	4475.6	10.6	Wf	4495.6	10.6	Pt
004958 W CASSIOPEIAE—						
	4472.4	10.8	Lp	4494.5	11.0	Lp
	4479.5	10.0	B	4495.6	10.5	Pt
005840 RX ANDROMEDAE—						
	4476.5	[12.6	Pt	4499.5	11.4	Pt
	4487.5	[12.0	Pt	4500.5	10.6	Cu
	4489.6	[12.4	Pt	4502.5	11.2	Cu
	4494.5	[12.6	Pt	4503.6	11.9	Pt
	4495.7	12.6	Pt	4504.4	12.5	Cu
010102 Z CETI—						
	4495.7	9 9	Pt			
010630 U SCULPTORIS—						
	4448.9	11.5	Bl			
010940 U ANDROMEDAE—						
	4475.6	14.2	Wf			
011041 UZ ANDROMEDAE—						
	4475.6	11.6	Wf			
011272 S CASSIOPEIAE—						
	4475.6	13.0	Wf	4495.7	13.0	Pt
012233a R SCULPTORIS—						
	4462.0	8.3	Kd			
012350 RZ PERSEI—						
	4479.5	10.3	B			
012502 R PISCIUM—						
	4470.0	[12.1	Ch			
013238 RU ANDROMEDAE—						
	4470.0	11.4	Ch	4492.6	11.3	Ie
	4475.6	11.2	Wf	4495.7	11.1	Pt
013338 Y ANDROMEDAE—						
	4470.0	[11.4	Ch	4495.7	11.5	Pt
014958 X CASSIOPEIAE—						
	4479.4	10.0	B	4495.7	10.7	Pt
015354 U PERSEI—						
	4483.4	9.0	B	4495.7	9.0	Pt
	4492.6	10.8	Hu			
015912 S ARIETIS—						
	4495.7	13.0	Pt			
021024 R ARIETIS—						
	4388.2	11.2	Cy	4479.5	7.5	B
	4462.1	8.3	Ch	4494.4	7.9	Lp
	4465.7	9.1	Cy	4494.6	7.7	Jo
	4471.0	9.0	Ch	4494.6	7.6	Ly
	4472.4	7.9	Lp	4495.7	7.6	Pt
	4474.6	7.8	Jo	4495.8	8.3	Cy
	4475.6	8.5	Wf	4496.6	8.2	Jo
	4476.6	7.8	Ly	4500.6	7 8	Ly
	4477.8	8.0	Cy	4500.6	8.0	Jo
	4478.1	7.6	Ch			
021143a W ANDROMEDAE—						
	4468.1	11.3	Ch	4475.7	10.8	Wf
	4475.1	11.2	Ch	4495.7	8.1	Pt
021258 T PERSEI—						
	4468.1	8 7	Ch	4495.7	8.5	Pt
	4492.6	8.2	Hu			
021281 Z CEPHEI—						
	4475.7	15.5	Wf			
021403 o CETI—						
	4387.7	8.6	Cy	4470.0	3.4	Ik
	4402.7	8.5	Cy	4471.0	3.8	Kd
	4444.7	5.7	Cy	4471.4	3.4	L
	4446.7	5 0	Cy	4472.2	3.6	Ch
	4447.0	4.9	Ik	4472.4	3.7	Lp
	4448.0	4.9	Ik	4472.7	3.5	Cy

VARIABLE STAR OBSERVATIONS RECEIVED DURING DECEMBER, 1925—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
021403 o CETI—Continued.						
	4449.0	4.9	Ik	4475.0	3.7	Kd
	4452.1	4.9	Kd	4475.6	3.7	Wf
	4452.2	3 9	Ch	4476.0	3.8	Kd
	4457.2	3.9	Ch	4476.1	3.6	Ch
	4458.2	4.2	Ch	4476.6	3.5	Ly
	4459.1	4.5	Ik	4476.8	3.6	Cy
	4460.0	4.1	Kd	4477.0	3.6	Kd
	4460.1	4 5	Ik	4479.2	3.6	Ch
	4461.0	3.9	Kd	4479.4	3.5	Cy
	4461.0	4.4	Ik	4484.4	3.0	L
	4461.2	3.9	Ch	4490.6	3.0	Jo
	4462.1	3.9	Ik	4491.6	3.2	Jo
	4464.1	3.9	Ik	4492.6	3.5	Hu
	4464.8	3.8	Cy	4493.5	3.3	Lp
	4467.2	3.6	Ch	4493.7	3.2	Cy
	4468.0	3.9	Kd	4494.6	3.0	Jo
	4468.0	3.8	Ik	4494.6	3.0	Ly
	4468 6	3.8	Cy	4495.7	3.0	Pt
	4469.0	3.7	Kd	4495.8	3.6	Cy
	4469.1	3.7	Ch	4498.6	2.9	Jo
	4469.9	3.7	Kd	4499.4	3.5	Cy
021558 S PERSEI—						
	4405.4	10.6	Kl	4472.4	10.4	Lp
	4410.4	10 7	Kl	4476.2	10.2	Kl
	4414.4	10.6	Kl	4481.2	10.2	Kl
	4422.4	10.5	Kl	4481.5	9.4	B
	4429.3	10.3	Kl	4492.6	9.5	Hu
	4431 3	10.3	Kl	4493.2	10.2	Kl
	4466.2	10 3	Kl	4494.5	9.8	Lp
	4468.1	10.2	Ch	4495.7	9.5	Pt
	4472.2	10.2	Kl	4500.6	9.8	Cu
022000 R CETI—						
	4468.1	[10.6	Ch			
022150 RR PERSEI—						
	4475.7	15.1	Wf	4498.5	[13 5	Ie
022426 R FORNACIS—						
	4448.9	9.7	Bl			
022812 U CETI—						
	4468.1	[11.0	Ch	4495.7	11.6	Pt
022908 RR CEPHEI—						
	4475.7	12.6	Wf			
023133 R TRIANGULI—						
	4387.7	5.8	Cy	4491.6	9.4	To
	4462.1	8.9	Ch	4495 7	10.0	Pt
	4465.7	9.3	Cy	4495.8	9.8	Cy
	4471.0	9.4	Ch	4496.6	9.5	To
	4474.6	9.4	Jo	4500.6	9.7	Jo
	4477.8	9.2	Cy			
024356 W PERSEI—						
	4387.7	9 3	Cy	4478.3	9.5	Cy
	4398.7	9.3	Cy	4481.5	9.2	B
	4403.7	9.3	Cy	4492.6	9.0	Hu
	4445.1	9.0	Cy	4495.7	9.0	Pt
	4466.2	9.2	Cy	4496.3	9.3	Cy
	4477.2	9.2	Ch			
025050 R HOROLOGII—						
	4448.9	5.9	Bl			
025751 T HOROLOGII—						
	4448.9	12.0	Bl			
031401 X CETI—						
	4475.3	10.1	L	4491.6	9.6	Jo
	4475.7	9.9	Wf	4494.6	9.5	Jo
	4478.5	10.3	B	4495.7	9.5	Pt
	4485.2	9 8	L	4503.6	9.7	Hu
032043 Y PERSEI—						
	4478.1	8.4	Ch	4492.6	8.4	Hu
	4481.5	8.6	B	4495.7	8.4	Pt
032335 R PERSEI—						
	4475.7	14.0	Wf	4494.4	13.0	Lp
042209 R TAURI—						
	4472.5	13.3	B	4490.5	12.9	B
042215 W TAURI—						
	4387 7	10.2	Cy	4481.5	12.4	B
	4464.8	11.5	Cy	4493.7	12.3	Cy
	4476.8	12.2	Cy	4495.7	11.9	Pt
042309 S TAURI—						
	4462.2	[10.6	Ch	4490.5	[13.0	B
043065 T CAMELOPARDALIS—						
	4475.3	12.3	L	4495.7	12.5	Pt
043208 RX TAURI—						
	4472.5	12 9	B	4490.5	12.9	B
043263 R RETICULI—						
	4448.9	8.5	Bl			
043274 X CAMELOPARDALIS—						
	4472.5	12.6	B	4495.7	10.1	Pt
043562 R DORADUS—						
	4448.9	5.4	Bl			
044340 R PICTORIS—						
	4449.0	7.3	Bl			
044617 V TAURI—						
	4475.7	13.6	Wf	4494.4	12.8	Lp
	4476.5	13.4	B	4499 5	13.8	B
	4490.5	13.8	B			
045307 R ORIONIS—						
	4478.6	10.2	B	4497.5	10.1	B
	4489.5	10.2	B			
045514 R LEPORIS—						
	4464.2	9.8	Ch	4498.7	8.6	Jo
	4475.6	9.0	L	4500.7	8 5	Jo
	4476.8	8.6	Pt			
050003 V ORIONIS—						
	4464.2	11.0	Ch	4477.5	12.2	B
	4476.8	11.5	Pt	4499.6	13.3	B
050022 T LEPORIS—						
	4476.8	9.3	Pt			
050954 R AURIGAE—						
	4473.2	11.1	Ch	4476 8	11.1	Pt
	4475.7	11.3	Wf	4484.9	11.3	Bi
	4476.6	10.6	B			
051247 T PICTORIS—						
	4449.0	8.0	Bl			
052034 S AURIGAE—						
	4469.2	9.2	Ch	4476.8	8.2	Pt
052036 W AURIGAE—						
	4476.6	13.0	Ie	4490.5	11.4	B
052401 S ORIONIS—						
	4476.5	9.9	B	4476.8	10.2	Pt
	4488.5	9.4	B			

VARIABLE STAR OBSERVATIONS RECEIVED DURING DECEMBER, 1925—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
053005a T ORIONIS—						
	4463.4	9.9	L	4494.8	10.1	Pt
	4474.9	10.2	Pt	4495.7	9.9	Pt
	4475.4	10.1	L	4497.5	9.8	B
	4476.6	10.0	B	4499.6	10.0	Pt
	4476.8	10.2	Pt	4502.7	10.1	Pt
	4484.7	10.0	L	4503.6	10.1	Pt
	4488.5	10.0	B			
053068 S CAMELOPARDALIS—						
	4476.8	9.7	Pt			
053326 RR TAURI—						
	4478.6	12.6	B	4490.5	12.7	B
053337 RU AURIGAE—						
	4476.8	[12.4	Pt			
053531 U AURIGAE—						
	4469.2	10.9	Ch	4488.5	10.8	B
	4476.8	10.5	Pt	4502.6	11.5	Ie
	4479.5	10.5	B			
054319 SU TAURI—						
	4461.2	9.7	Ch	4490.5	9.8	B
	4469.2	9.7	Ch	4492.6	9.9	Hu
	4473.2	9.6	Ch	4492.6	10.2	Ie
	4473.5	9.8	B	4494.8	10.5	Pt
	4474.9	9.6	Pt	4495.7	10.5	Pt
	4474.9	9.7	L	4498.5	10.7	Ie
	4475.6	9.6	Pt	4499.5	11.3	Pt
	4475.7	10.0	Wf	4501.7	11.6	Cu
	4476.5	9.5	B	4502.5	12.4	Cu
	4476.8	9.7	Pt	4502.5	11.8	Ie
	4478.5	9.6	B	4502.7	12.0	Pt
	4484.7	9.6	L	4503.6	12.4	Pt
	4489.6	9.6	Pt	4503.8	12.2	Cu
054615a Z TAURI—						
	4498.6	14.0	Ie			
054615c RU TAURI—						
	4498.6	14.1	Ie			
054920a U ORIONIS—						
	4462.2	8.6	Ch	4491.6	9.0	Jo
	4464.8	8.9	Cy	4492.6	9.9	Hu
	4473.2	8.9	Ch	4492.7	9.8	Gb
	4476.8	9.0	Cy	4493.7	9.6	Cy
	4476.8	8.9	Pt	4494.4	9.9	Lp
	4484.9	8.6	Bi	4498.6	9.0	Jo
054920b VW ORIONIS—						
	4465.3	10.4	Cy	4493.7	10.4	Cy
	4476.8	10.5	Cy	4495.7	10.4	Cy
	4484.9	10.5	Bi			
054974 V CAMELOPARDALIS—						
	4475.7	14.0	Wf	4497.5	11.1	B
	4495.7	11.5	Pt	4498.6	11.2	Ie
055353 Z AURIGAE—						
	4469.2	9.6	Ch	4489.6	9.8	Pt
	4472.6	9.8	B	4490.5	10.1	B
	4474.9	9.4	Pt	4494.8	10.0	Pt
	4475.7	10.1	Wf	4497.5	10.2	B
	4476.5	9.9	B	4499.5	10.1	Pt
	4476.8	9.0	Pt	4503.5	10.0	Pt
	4480.5	10.0	B			
060450 X AURIGAE—						
	4462.2	10.0	Ch	4475.2	11.6	Ch
	4469.2	10.5	Ch	4476.8	11.4	Pt
060450 X AURIGAE—Continued.						
	4471.2	11.2	Ch	4477.2	11.2	Ch
	4473.2	11.3	Ch	4481.5	11.2	B
060547 SS AURIGAE—						
	4472.3	12.2	Ch	4480.6	11.0	Wf
	4472.6	13.5	B	4481.6	11.3	Wf
	4473.2	11.2	Ch	4484.4	12.4	L
	4473.5	11.1	B	4484.9	12.4	Bi
	4474.2	10.7	Ch	4488.4	[13.3	B
	4474.9	10.8	Pt	4489.5	[13.5	B
	4475.2	10.8	Ch	4489.6	[12.4	Pt
	4475.3	10.6	L	4490.5	[13.8	B
	4475.6	10.6	Wf	4491.5	[12.6	Ie
	4475.7	10.9	L	4491.7	14.8	Du
	4476.5	10.8	Ch	4492.6	[13.3	Ie
	4476.5	11.1	B	4493.7	[13.5	Cy
	4476.5	10.7	Pt	4494.8	[12.6	Pt
	4476.6	10.6	Du	4495.7	[12.6	Pt
	4476.6	10.5	Wf	4495.8	[13.0	Cy
	4476.6	10.9	Ie	4496.4	[12.4	Cy
	4476.8	10.8	Cy	4496.9	[13.0	Cy
	4477.2	10.8	Ch	4497.5	[13.4	B
	4477.5	11.1	B	4498.5	[13.3	Ie
	4477.6	10.7	Du	4499.5	[12.6	Pt
	4478.1	10.8	Ch	4500.5	[12.4	Cu
	4478.5	11.0	B	4501.7	[13.3	Cu
	4478.6	10.8	Ie	4502.5	[13.0	Cu
	4478.7	10.8	Du	4502.5	[13.3	Ie
	4478.66	10.76	Du	4502.7	[12.4	Pt
	4479.2	10.9	Ch	4503.5	[12.6	Pt
	4479.4	10.6	Cy	4503.8	[13.3	Cu
	4479.5	11.2	B	4508.6	[13.0	Cu
	4480.5	11.3	B			
061647 V AURIGAE—						
	4497.5	11.4	B			
061702 V MONOCEROTIS—						
	4472.2	11.5	Ch	4476.8	11.3	Pt
063308 R MONOCEROTIS—						
	4476.8	10.4	Pt			
063462 NOVA PICTORIS—						
	4428.0	3.9	Bl	4433.0	4.2	Bl
	4429.0	3.9	Bl	4436.0	4.1	Bl
	4430.0	4.0	Bl	4444.0	4.1	Bl
	4431.0	4.1	Bl	4448.0	4.2	Bl
	4425.0	4.3	Bl	4449.0	4.2	Bl
063558 S LYNCIS—						
	4472.7	9.8	Ch	4476.8	10.0	Pt
064707 W MONOCEROTIS—						
	4476.8	9.4	Pt			
065111 Y MONOCEROTIS—						
	4469.2	9.5	Ch	4484.9	8.9	Bi
	4476.8	9.4	Pt			
065208 X MONOCEROTIS—						
	4472.2	9.5	Ch	4503.6	8.4	Hu
	4475.6	9.1	L			
065355 R LYNCIS—						
	4475.7	11.2	Wf	4480.6	11.7	B
	4498.6	12.2	Ie			
070109 V CANIS MINORIS—						
	4469.2	9.3	Ch			

VARIABLE STAR OBSERVATIONS RECEIVED DURING DECEMBER, 1925—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
070122a R GEMINORUM—						
	4469.2	6.7	Ch	4495.6	6.5	Al
	4475.7	7.1	Wf	4498.7	7.0	Jo
	4476.8	6.5	Pt	4503.6	7.9	Hu
	4484.9	6.6	Bi			
070122b Z GEMINORUM—						
	4476.8	12.4	Pt	4484.9	12.3	Bi
070122c TW GEMINORUM—						
	4476.8	8.1	Pt	4484.9	8.1	Bi
070310 R CANIS MINORIS—						
	4475.6	7.6	L	4503.6	8.0	Hu
	4492.6	8.0	Hu			
071201 RR MONOCEROTIS—						
	4470.4	9.5	Ch	4485.0	8.5	Bi
071713 V GEMINORUM—						
	4476.8	11.7	Pt			
072708 S CANIS MINORIS—						
	4465.3	10.2	Cy	4476.8	9.6	Cy
	4472.2	9.7	Ch	4491.6	9.0	Jo
	4475.6	9.6	L	4496.9	9.0	Cy
	4476.8	9.5	Pt	4498.7	8.6	Jo
072811 T CANIS MINORIS—						
	4476.8	13.5	Pt			
073508 U CANIS MINORIS—						
	4475.7	12.9	L	4476.8	11.9	Pt
073723 S GEMINORUM—						
	4473.2	[11.5	Ch	4478.5	12.7	Ch
074323 T GEMINORUM—						
	4475.2	11.0	Ch	4478.5	10.9	Ch
074922 U GEMINORUM—						
	4462.2	[9.3	Ch	4491.71	9.80	Du
	4464.8	[12.4	Cy	4492.6	9.5	Ie
	4467.3	[11.7	Ch	4492 8	9.6	Du
	4469.2	[11.7	Ch	4492.80	9.79	Du
	4470.4	[12.4	Ch	4493.7	9.6	Cy
	4472.2	[12.2	Ch	4494.4	9.8	Lp
	4473.2	[11.7	Ch	4494.8	9.5	Pt
	4474.2	[12.4	Ch	4494.8	9.8	Du
	4475.2	[12.3	Ch	4494.80	10.01	Du
	4475.7	14.0	Wf	4495.6	9.7	B
	4476.5	[12.3	Ch	4495.7	9.5	Pt
	4477.2	[10.9	Ch	4495.8	9.6	Cy
	4478.7	13.8	Du	4496.9	10.0	Cy
	4478.9	14.0	Du	4498.6	13.2	Ie
	4484.4	[12.4	L	4499.6	13 0	Pt
	4485.0	14.0	Di	4501.7	13.4	Cu
	4490.5	13.1	B	4502.7	[12.6	Cu
	4490.7	12.9	Du	4503.8	[13.3	Cu
	4491.6	9.7	Du			
075612 U PUPPIS—						
	4470.5	[11.8	Ch			
081112 R CANCRI—						
	4470.4	11.0	Ch	4476.8	10.7	Pt
	4475.7	10.7	L			
081617 V CANCRI—						
	4470.4	8.8	Ch	4476.8	8.6	Pt
081633 T LYNCIS—						
	4503.6	9.0	Hu			
082405 RT HYDRAE—						
	4476.8	8.0	Pt			
083019 U CANCRI—						
	4475.8	11.0	Wf	4485.0	11.0	Bi
083350 X URSAE MAJORIS—						
	4476.8	12.8	Pt	4485.0	12.1	Bi
084803 S HYDRAE—						
	4470.4	7.6	Ch	4476.8	8.2	Pt
085008 T HYDRAE—						
	4475.7	12.3	L	4476.8	12.5	Pt
085120 T CANCRI—						
	4470.4	9.5	Ch	4476.8	8.3	Pt
090425 W CANCRI—						
	4475.8	13.9	Wf			
093014 X HYDRAE—						
	4470.4	10.9	Ch	4476.8	10.8	Pt
093178 Y DRACONIS—						
	4388.1	13.3	Cy	4402.6	[12.9	Cy
093934 R LEONIS MINORIS—						
	4470.4	[11.6	Ch	4476.8	12.7	Pt
09411 R LEONIS—						
	4470.4	9.8	Ch	4477.3	9.6	Cy
	4476.8	8.8	Pt			
095421 V LEONIS—						
	4475.8	13.0	Wf	4476.8	12.4	Pt
	4476.8	12.4	Cy	4485.0	12.8	Bi
103212 U HYDRAE—						
	4466.3	5.5	Kd	4477.3	5.6	Kd
	4470.3	5.7	Kd	4481.8	5.6	Kd
	4475.7	5.0	L			
103769 R URSAE MAJORIS—						
	4387.6	11.8	Cy	4476.8	7.7	Pt
	4402.6	11.7	Cy	4480.6	8.2	Wf
	4470.4	7.8	Ch	4496.9	9.5	Cy
104620 V HYDRAE—						
	4470.4	11.9	Ch	4476.9	11.5	Pt
	4475.7	11.6	L			
104814 W LEONIS—						
	4475.4	[11.2	Ch	4485.0	13.0	Bi
110506 S LEONIS—						
	4475.4	[11.8	Ch	4476.9	12.3	Pt
111661 RS CENTAURI—						
	4424.9	10.8	Bl			
115058 W CENTAURI—						
	4424.9	10.4	Bl	4447.9	8.8	Bl
115919 R COMAE BERENICES—						
	4476.4	[10.9	Ch	4485.0	13.0	Bi
120012 SU VIRGINIS—						
	4475.4	[12.0	Ch			
121418 R CORVI—						
	4475.7	10.4	L	4476.9	10.3	Pt
122001 SS VIRGINIS—						
	4475.7	6.5	L	4481.3	7.7	Kd
	4477.3	7.8	Kd			
122532 T CANUM VENATICORUM—						
	4476.9	9.5	Pt			
122803 Y VIRGINIS—						
	4475.7	11.6	L			
123160 T URSAE MAJORIS—						
	4369.0	8 2	Ik	4391.0	9.0	Ik
	4371.0	8.2	Ik	4405.4	9.7	Kl
	4374.0	8.3	Ik	4407.4	9.8	Kl
	4375.0	8.5	Ik	4410.4	9.9	Kl

VARIABLE STAR OBSERVATIONS RECEIVED DURING DECEMBER, 1925—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
123160 T URSAE MAJORIS—Continued.						
	4382.0	8.6	Ik	4414.3	10.1	Kl
	4384.0	8.6	Ik	4422.4	10.4	Kl
	4386.0	8.7	Ik	4429.3	10.8	Kl
	4387.0	8.8	Ik	4431.3	10.7	Kl
	4387.6	8.9	Cy	4480.6	13.0	Wf
	4390.0	8.8	Ik	4480.9	12.8	Pt
123307 R VIRGINIS—						
	4475.7	11.4	L	4480.9	10.8	Pt
123459 RS URSAE MAJORIS—						
	4476.5	9.9	Ch	4480.9	9.6	Pt
	4476.8	10.2	Cy	4496.9	9.0	Cy
	4480.6	9.8	Wf			
123961 S URSAE MAJORIS—						
	4387.6	11.5	Cy	4459.3	8.1	Kb
	4405.4	10.7	Kl	4459.9	7.7	Ik
	4407.4	11.2	Kl	4460.9	7.7	Ik
	4410.4	10.4	Kl	4461.9	7.7	Ik
	4418.3	10.2	Kl	4466.2	8.4	Kl
	4422.4	10.0	Kl	4466.3	8.0	Kb
	4424.3	8.9	Kl	4470.3	8.1	Kb
	4428.2	8.7	Kl	4472.2	8.5	Kl
	4431.3	8.8	Kl	4472.4	8.3	Lp
	4433.3	8.5	Kl	4473.3	8.0	Kb
	4443.9	8.2	Ik	4475.6	7.5	L
	4444.9	8.2	Ik	4476.2	8.2	Kl
	4445.9	8.2	Ik	4476.5	8.2	Ch
	4446.9	8.1	Ik	4480.6	8.0	Wf
	4447.9	8.1	Ik	4480.9	8.0	Pt
	4448.3	8.1	Kb	4481.2	8.2	Kl
	4449.9	8.1	Ik	4492.7	8.0	Gb
	4450.9	8.1	Ik	4493.2	8.3	Kl
	4452.3	8.2	Kb	4494.4	7.9	Lp
	4458.2	8.0	L	4496.9	8.2	Cy
124606 U VIRGINIS—						
	4480.9	8.0	Pt			
131283 U OCTANTIS—						
	4424.9	11.9	Bl	4447.9	12.8	Bl
132422 R HYDRAE—						
	4424.9	8.0	Bl	4484.7	9.4	L
	4477.5	9.3	Ch	4503.9	9.1	Pt
132706 S VIRGINIS—						
	4480.9	12.2	Pt			
133155 RV CENTAURI—						
	4424.9	7.5	Bl	4453.9	7.3	Bl
	4447.9	7.2	Bl			
133273 T URSAE MINORIS—						
	4480.6	13.0	Wf			
133633 T CENTAURI—						
	4424.9	5.7	Bl			
134236 RT CENTAURI—						
	4424.9	8.8	Bl			
134440 R CANUM VENATICORUM—						
	4449.3	8.0	Kb	4466.3	8.4	Kb
	4452.3	7.7	Kb	4480.9	8.4	Pt
134536 RX CENTAURI—						
	4424.9	11.2	Bl			
134677 T APODIS—						
	4424.9	10.3	Bl	4453.9	12.4	Bl
	4447.9	12.1	Bl			
140959 R CENTAURI—						
	4424.9	10.0	Bl	4447.9	10.9	Bl
141567 U URSAE MINORIS—						
	4476.5	7.6	Ch	4480.9	7.8	Pt
141954 S BOOTIS—						
	4388.6	8.9	Cy	4475.6	13.0	Wf
	4458.2	12.4	L	4480.9	13.4	Pt
142539 V BOOTIS—						
	4383.1	9.4	Cy	4454.6	7.7	Cy
	4383.1	9.2	Bz	4463.2	7.7	L
	4388.1	9.1	Cy	4475.6	8.0	L
	4392.6	8.7	Cy	4476.5	7.9	Ch
	4397.6	8.1	Cy	4480.9	7.8	Pt
	4402.6	8.1	Cy	4496.9	8.1	Cy
142584 R CAMELOPARDALIS—						
	4475.6	13.7	Wf	4494.5	11.5	Lp
143227 R BOOTIS—						
	4388.6	6.9	Cy	4480.9	12.4	Pt
144918 U BOOTIS—						
	4387.6	12.6	Cy	4402.6	11.6	Cy
	4397.6	11.7	Cy			
145254 Y LUPI—						
	4447.9	12.8	Bl			
145971 S APODIS—						
	4424.9	9.9	Bl	4453.9	9.8	Bl
	4447.9	9.9	Bl			
150605 Y LIBRAE—						
	4484.7	9.2	L			
151714 S SERPENTIS—						
	4388.6	8.9	Cy	4463.2	10.9	L
151731 S CORONAE BOREALIS—						
	4387.7	12.4	Cy	4480.9	7.0	Pt
	4456.0	8.0	Ch			
151822 RS LIBRAE—						
	4424.9	10.3	Bl	4447.9	9.7	Bl
152849 R NORMAE—						
	4424.9	7.2	Bl	4453.9	8.0	Bl
	4447.9	7.7	Bl			
153378 S URSAE MINORIS—						
	4387.6	12.5	Cy	4479.6	9.6	Cy
	4464.7	9.6	Cy	4480.9	9.5	Pt
	4476.6	9.5	Du	4496.5	8.8	Cy
153620a U LIBRAE—						
	4424.9	11.0	Bl			
154020 Z LIBRAE—						
	4424.9	11.0	Bl	4426.9	11.6	Bl
154428 R CORONAE BOREALIS—						
	4377.6	5.8	Cy	4452.3	6.1	Kb
	4378.7	6.0	Cy	4456.0	6.0	Ch
	4382.6	6.0	Cy	4458.2	6.1	L
	4384.6	6.0	Cy	4458.4	6.0	Cy
	4387.6	6.0	Cy	4460.9	6.0	Kd
	4388.6	6.0	Cy	4462.9	6.1	Kd
	4389.6	6.1	Cy	4463.2	6.0	L
	4390.6	6.2	Cy	4466.3	6.0	Kb
	4392.6	6.1	Cy	4466.6	6.0	Cy
	4393.6	6.1	Cy	4468.9	6.1	Kd
	4395.6	6.1	Cy	4474.9	6.2	Pt
	4396.6	6.1	Cy	4475.2	6.2	L
	4397.6	6.1	Cy	4475.6	6.0	Wf
	4398.6	6.1	Cy	4475.6	6.1	Pt

VARIABLE STAR OBSERVATIONS RECEIVED DURING DECEMBER, 1925—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
154428 R Cor. Bor.—Continued.						
	4402.6	6.1	Cy	4476.4	6.0	Cy
	4405.3	6.2	Kl	4475.6	6.2	Pt
	4408.3	6.2	Kl	4477.3	6.3	Kd
	4410.4	6.2	Kl	4478.4	6.2	Ie
	4411.3	6.2	Kl	4480.5	6.2	Pt
	4414.3	6.3	Kl	4481.3	6.3	Kd
	4422.4	6.3	Kl	4481.6	6.2	Pj
	4429.3	6.3	Kl	4484.7	6.0	L
	4431.3	6.0	Kl	4496.9	6.0	Cy
	4435.6	6.3	Pj	4499.5	6.0	Gb
	4449.3	6.0	Kb	4503.9	6.1	Pt
	4451.6	6.1	Cy	4503.9	5.9	Du
154536 X Coronae Borealis—						
	4387.7	9.2	Cy	4397.6	9.2	Cy
154615 S Serpentis—						
	4388.7	13.0	Cy	4503.9	8.7	Pt
154639 V Coronae Borealis—						
	4387.7	7.9	Cy	4480.6	8.0	Wf
	4402.6	7.6	Cy	4480.9	7.2	Pt
155229 Z Coronae Borealis—						
	4402.6	13.0	Cy			
160021 Z Scorpii—						
	4424.9	9.3	Bl	4447.9	9.0	Bl
160210 U Serpentis—						
	4387.6	[12.0	Cy	4503.9	8.5	Pt
	4402.6	[12.0	Cy			
160325 SX Herculis—						
	4463.2	7.9	L	4476.5	8.1	Pt
	4475.2	8.0	L	4484.7	7.7	L
	4475.6	8.0	Pt	4503.9	8.8	Pt
160625 RU Herculis—						
	4463.2	8.0	L	4484.7	7.8	L
	4475.2	7.9	L	4503.9	8.6	Pt
161138 W Coronae Borealis—						
	4480.6	12.2	Wf			
162119 U Herculis—						
	4405.3	10.2	Kl	4429.3	10.7	Kl
	4408.7	10.2	Kl	4431.3	10.7	Kl
	4410.4	10.2	Kl	4503.9	13.3	Pt
	4414.3	10.1	Kl			
162807 SS Herculis—						
	4388.7	10.6	Cy	4470.2	12.1	L
	4402.7	9.8	Cy			
163137 W Herculis—						
	4461.0	[11.2	Sh	4495.5	13.8	Pt
163172 R Ursae Minoris—						
	4472.4	9.4	Lp			
163266 R Draconis—						
	4471.0	10.8	Ch	4495.5	12.0	Pt
	4494.5	11.8	Lp			
164715 S Herculis—						
	4369.0	9.6	Ik	4384.0	9.9	Ik
	4371.0	9.6	Ik	4386.0	9.9	Ik
	4374.0	9.6	Ik	4387.0	9.9	Ik
	4375.0	9.6	Ik	4391.0	10.1	Ik
	4382 0	10.0	Ik			
164844 RS Scorpii—						
	4424.9	12.0	Bl	4447.9	[12.0	Bl
165030 RR Scorpii—						
	4424.9	8.7	Bl	4453.9	7.7	Bl
	4447.9	8.3	Bl			
165631 RV Herculis—						
	4495.5	13.2	Pt			
165636 RT Scorpii—						
	4447.9	10.9	Bl	4454.9	10.6	Bl
170627 RT Herculis—						
	4480.6	12.2	Wf			
170833 RW Scorpii—						
	4447.9	[12.5	Bl			
171723 RS Herculis—						
	4495.5	7.7	Pt			
172486 S Octantis—						
	4424.9	9.2	Bl	4448.0	9.2	Bl
172809 RU Ophiuchi—						
	4495.5	11.5	Pt			
173543 RU Scorpii—						
	4425.0	8.7	Bl	4453.9	8.5	Bl
	4447.9	8.6	Bl			
174135 SV Scorpii—						
	4425.0	11.3	Bl	4453.9	10.5	Bl
	4448 0	10.7	Bl			
174162 W Pavonis—						
	4448.0	[12.3	Bl			
175458a T Draconis—						
	4475.7	12.2	Wf			
175458b UY Draconis—						
	4475.7	11.1	Wf			
175519 RY Herculis—						
	4459.1	11.7	Ch	4495.5	13.5	Pt
175654 V Draconis—						
	4495.5	13.5	Pt			
180531 T Herculis—						
	4459.1	12.0	Ch	4485.2	9.3	L
	4475.2	10.8	L	4495.5	7.8	Pt
	4475.7	10.9	Wf			
181031 TV Herculis—						
	4463.4	[14.0	L	4485.2	13.0	L
	4475.2	[14.0	L			
181103 RY Ophiuchi—						
	4495.5	11.3	Pt			
181136 W Lyrae—						
	4470.2	9.7	L	4485.2	10.8	L
	4475.7	10.3	Wf	4488 4	11.2	B
	4480.4	10.5	B	4495.5	12.0	Pt
182133 RV Sagittarii—						
	4425.0	12.3	Bl	4453.9	11.9	Bl
	4448.0	11.7	Bl			
182224 SV Herculis—						
	4472.2	13.0	L			
182306 T Serpentis—						
	4495.5	9.5	Pt			
183308 X Ophiuchi—						
	4387.6	8.0	Cy	4476.5	7.0	Ly
	4388.6	8.2	Cy	4485.2	6.8	L
	4402.6	8.2	Cy	4495.4	6.7	Cy
	4470.1	7.0	Ch	4495.5	6.2	Pt
	4470.2	6.7	L	4499.4	6.7	Cy
	4476.4	6.8	Cy			

VARIABLE STAR OBSERVATIONS RECEIVED DURING DECEMBER, 1925—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
184134 RY LYRAE—						
	4495.5	11.0	Pt			
184243 RW LYRAE—						
	4476.4	13.5	B			
184205 R SCUTI—						
	4378.1	5.8	Cy	4463.2	7.4	L
	4379.2	5.8	Cy	4466.3	7.8	Kb
	4383.1	5.8	Cy	4468.4	7.7	Cy
	4383.1	6.1	Bz	4468 9	7.7	Kd
	4384.6	5.7	Cy	4470.2	7.3	L
	4387.6	5.5	Cy	4470.3	7.3	Kb
	4388.6	5.0	Cy	4470.9	7.8	Kd
	4389.6	5.0	Cy	4472.1	7.2	Ch
	4390 6	6.0	Cy	4473.3	7.1	Kb
	4391.6	5.0	Cy	4473.9	7.3	Kd
	4392.6	5.0	Cy	4475.3	6.9	L
	4393.6	5.0	Cy	4475.6	7.0	Pt
	4394.6	5.0	Cy	4476.4	7.0	Cy
	4395.6	5.0	Cy	4476 5	7.0	Ly
	4396.6	5.0	Cy	4478.5	6.9	Ie
	4397.6	5.0	Cy	4478.5	6.9	Du
	4398.6	5.0	Cy	4479.4	6.5	Cy
	4402.6	5.0	Cy	4480.5	6.6	Pt
	4444.6	7.2	Cy	4485.2	6.1	L
	4448.3	7.5	Kb	4487.5	6.6	Pt
	4448.9	7.3	Kd	4495.4	5.0	Cy
	4452.3	7.7	Kb	4495.5	5.4	Pt
	4458.4	7.3	Cv	4496.4	5.0	Cy
	4459.3	7.9	Kb	4498.5	5.3	Ie
	4460.1	7.4	Ch	4499.4	5.0	Cy
	4461.9	7.8	Kd	4499.5	5.2	Pt
	4462.9	7.8	Kd	4503.5	5.4	Pt
184300 NOVA AQUILAE—						
	4461.0	10.4	Ch	4495.5	10.4	Pt
	4475 6	10.6	Pt	4499.5	10.6	Pt
	4487.5	10.3	Pt	4503.5	10.5	Pt
185032 RX LYRAE—						
	4459.1	11.4	Ch	4495.5	12.1	Pt
	4469.1	10.9	Ch			
185437a S CORONAE BOREALIS—						
	4448.0	12.5	Bl			
185512a ST SAGITTARII—						
	4468.0	[11.2	Ch			
185537a R CORONAE AUSTRALIS—						
	4425.0	10.4	Bl	4448.0	10.9	Bl
	4426 9	10.4	Bl	4453.9	11.0	Bl
185537b T CORONAE AUSTRALIS—						
	4448.0	[12.5	Bl			
185634 Z LYRAE—						
	4478.4	10.7	B	4495.5	10.6	Pt
	4488.4	10.5	B			
185737 RT LYRAE—						
	4459.1	11.9	Ch	4469.1	11.1	Ch
190108 R AQUILAE—						
	4461.1	5.8	Ch	4480.4	5.7	B
	4470.1	5.6	Ch	4495.5	6.0	Pt
190818 RX SAGITTARII—						
	4468.0	9.6	Ch			
190819b RW SAGITTARII—						
	4468.0	11.0	Ch			
190907 TY AQUILAE—						
	4495.5	10.0	Pt			
190925 S LYRAE—						
	4459.1	[11.1	Ch			
190926 X LYRAE—						
	4495.5	9.0	Pt			
190933a RS LYRAE—						
	4459.1	[11.8	Ch			
190941 RU LYRAE—						
	4476.5	11.1	Ie	4495.5	11.4	Pt
190967a Y DRACONIS—						
	4464.1	[12.1	Ch	4495.5	13.6	Pt
191007 W AQUILAE—						
	4461.1	9.5	Ch	4495.5	9.6	Pt
	4472.1	9.5	Ch			
191017 T SAGITTARII—						
	4468.0	10.8	Ch			
191019 R SAGITTARII—						
	4369.0	8.9	Ik	4474.0	9.0	Ik
	4471.0	8.9	Ik	4475.0	9.1	Ik
191033 RY SAGITTARII—						
	4425.0	6.8	Bl	4468 9	6.8	Kd
	4448.0	6.5	Bl	4469.9	6.8	Kd
	4453.9	6.5	Bl	4475.5	6.6	Pt
	4468.0	6.5	Ch	4476.5	6.6	Pt
191124 TY SAGITTARII—						
	4425.0	10.8	Bl	4453.9	10.3	Bl
	4448 0	10.1	Bl			
191331 SW SAGITTARII—						
	4425.0	11.7	Bl	4453.9	10.1	Bl
	4448.0	10.1	Bl			
191350 TZ CYGNI—						
	4495.6	10.6	Pt			
191637 U LYRAE—						
	4495.6	10.0	Pt			
192928 TY CYGNI—						
	4460.1	[11.2	Ch	4495.6	12.5	Pt
193311 RT AQUILAE—						
	4461.1	[11.0	Ch			
193449 R CYGNI—						
	4387.6	5.0	Cy	4474 6	7.2	Jo
	4432.6	6.7	Pj	4475.1	6.5	Ch
	4435.6	6.5	Pj	4475.7	7.0	Wf
	4446.7	6.2	Cy	4476.5	6.7	Ie
	4448.3	6.9	Kb	4476.6	7.7	Cy
	4449.3	6.8	Kb	4480.4	7.2	B
	4452.3	6.6	Kb	4480.6	6.8	Pj
	4458.7	6.8	Pj	4490.7	7.5	Gs
	4459.1	6.5	Ch	4491.6	7.7	Jo
	4459.3	6.7	Kb	4493.6	8.6	Cy
	4464.6	7.3	Cy	4494 5	9.1	Ly
	4466.3	6.9	Kb	4494.6	7.5	Jo
	4467.2	6.4	Ch	4495.6	7.3	Pt
	4469.3	7.0	Kb	4496.6	8.0	Jo
	4469.7	7.0	Gs	4497.5	8.0	Bx
	4473.7	7.5	Gb	4497.7	8.5	Gs
	4474.5	7.0	Bx	4498.6	7.2	Hu
	4474.7	6.6	Gs	4500.6	8.1	Jo
193509 RV AQUILAE—						
	4495.6	9.5	Pt			

VARIABLE STAR OBSERVATIONS RECEIVED DURING DECEMBER, 1925—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
193732 TT CYGNI—						
	4498.6	7.4	Hu			
193972 T PAVONIS—						
	4448.0	13.0	Bl			
194048 RT CYGNI—						
	4387.7	8.9	Cy	4473.3	8.6	Kb
	4446.7	7.6	Cy	4473.7	8.4	Gb
	4448.3	7.7	Kb	4474.6	8.1	Jo
	4449.3	7.8	Kb	4475.1	8.5	Ch
	4452.3	7.9	Kb	4476.6	8.8	Cy
	4459.1	7.6	Ch	4480.4	8.7	B
	4459.3	8.2	Kb	4491.6	9.0	Jo
	4464.6	8.0	Cy	4493.6	9.1	Cy
	4466.3	8.3	Kb	4494.6	8.8	Jo
	4467.2	8.3	Ch	4495.6	9.1	Pt
	4469.3	8.4	Kb	4498.6	9.6	Hu
	4470 3	8.5	Kb	4500.6	9.5	Jo
194348 TU CYGNI—						
	4459.1	[11.2	Ch			
194604 X AQUILAE—						
	4476.6	12.6	Wf	4495.6	10.0	Pt
194632 χ CYGNI—						
	4458.7	8.0	Pj	4472.4	7.1	Lp
	4460.1	7.8	Ch	4475.7	7.1	Wf
	4461.0	8.0	Kd	4476.4	7.0	B
	4462 0	7.9	Kd	4477.0	6.6	Kd
	4463.0	7.8	Kd	4481.9	6.8	Kd
	4469.0	7.0	Kd	4495.6	6.3	Pt
	4469.9	6.9	Kd	4498.6	7.0	Hu
	4472.1	7.0	Ch			
194939 RR SAGITTARII—						
	4425.0	7.1	Bl	4448.0	7.6	Bl
195142 RU SAGITTARII—						
	4426 9	7.7	Bl	4448.0	9.1	Bl
195202 RR AQUILAE—						
	4478.4	11.7	B			
195553 NOVA CYGNI—						
	4475.6	12.6	Pt	4494.5	12.6	Pt
	4487.5	12.6	Pt	4499.5	12.6	Pt
	4489.6	12.6	Pt	4503.5	12.5	Pt
195849 Z CYGNI—						
	4460.1	11.5	Ch	4476.5	9.4	Ie
	4471.0	9.6	Ch	4476.6	9.6	Wf
	4474.6	9.2	Jo	4494.6	8.4	Jo
	4476.5	9.5	B	4495.6	7.9	Pt
195855 S TELESCOPII—						
	4448.0	[12.6	Bl			
200212 SY AQUILAE—						
	4475.3	11.3	L	4495.6	9.5	Pt
200357 S CYGNI—						
	4460.1	11.5	Ch	4476.5	11.9	Ie
	4472.1	11.2	Ch	4476.6	12.2	Wf
	4472.4	12.2	Lp	4490 4	13.1	B
	4476.5	12.1	B	4495.6	12.9	Pt
200514 R CAPRICORNI—						
	4468.0	10.8	Ch	4495.6	9.5	Pt
200647 SV CYGNI—						
	4480.5	8.4	B	4498.6	7.8	Hu
200715a S AQUILAE—						
	4462.1	10.2	Ch	4476.6	10.6	Wf
	4472 1	10.2	Ch	4495.6	9.5	Pt
200715b RW AQUILAE—						
	4495.6	9.1	Pt			
200747 R TELESCOPII—						
	4448.0	[13.0	Bl			
200906 Z AQUILAE—						
	4476.4	10.5	B	4495.6	11.8	Pt
200938 RS CYGNI—						
	4383.1	7.2	Cy	4473.7	8.8	Gb
	4383.1	8.2	Bz	4474.6	8.2	Jo
	4387.6	8.2	Cy	4475.3	8.2	L
	4392.6	8.2	Cy	4476.5	8.9	Ly
	4397.6	8.3	Cy	4476.6	9.0	Cy
	4402.7	8.8	Cy	4478.1	9.0	Ch
	4446.6	8.8	Cy	4485.2	8.2	L
	4456.2	8.7	Ch	4491.6	8.0	Jo
	4460.1	9.0	Ch	4493.6	9.0	Cy
	4463.4	8.1	L	4494.5	9.0	Ly
	4464.6	9.0	Cy	4494.6	8.5	Jo
	4467.2	9.0	Ch	4495.6	8.0	Pt
	4470.1	9.0	Ch	4499.4	9.3	Cy
	4473.2	9.1	Ch	4500.6	8.0	Jo
201008 R DELPHINI—						
	4462.1	11.5	Ch	4475.3	12.2	L
	4463.3	11.7	L	4489.4	12.6	B
	4472.5	12.1	B	4495.6	12.7	Pt
201121 RT CAPRICORNI—						
	4460 9	7.6	Kd	4495.6	6.3	Pt
201130 SX CYGNI—						
	4389.6	9.8	Cy	4476.6	12.8	Ie
	4402.7	10.2	Cy	4476.6	12.8	Cy
	4446.7	11.7	Cy	4490.5	12.8	B
	4476.5	12.7	B	4495.6	13.0	Pt
201139 RT SAGITTARII—						
	4426.9	10.2	Bl	4448.0	11.4	Bl
201437b WX CYGNI—						
	4387.6	10.7	Cy	4476.4	9.1	B
	4392.6	10.7	Cy	4476.6	10.6	Ie
	4397.6	10.6	Cy	4476.6	10.4	Cy
	4402.6	10.7	Cy	4476.6	10.5	Ly
	4446 7	10.4	Cy	4493.6	10.4	Cy
	4460.2	10.9	Ch	4494.6	10.5	Ly
	4464.7	10.5	Cy	4495.6	9.5	Pt
	4467.2	10.8	Ch	4499.6	10.5	Cy
	4473.7	10.0	Gb			
201647 U CYGNI—						
	4432.6	8.7	Pj	4491.6	7.6	Jo
	4458 7	8.0	Pj	4494.6	7.5	Jo
	4469.1	7.8	Ch	4495.6	7.3	Pt
	4474.6	7.7	Jo	4496.6	7.8	Jo
	4480.5	7.7	B	4500.6	7.7	Jo
	4481.7	7.0	Pj			
202240 U MICROSCOPII—						
	4426.9	10.8	Bl	4448.0	8.8	Bl
202817 Z DELPHINI—						
	4472 5	13.5	B	4489.5	[13.6	B
202946 SZ CYGNI—						
	4475.6	9.6	Pt	4489.6	9.8	Pt
	4476.5	9.8	Pt	4494.5	8.9	Pt
	4478.5	9.6	B	4495.6	8.8	Pt
	4480.5	8.8	Pt	4499.5	9.2	Pt
	4487.5	9.8	Pt	4503.5	9.8	Pt

VARIABLE STAR OBSERVATIONS RECEIVED DURING DECEMBER, 1925—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
202954 ST CYGNI—						
	4476.5	10.1	Ie	4495.6	9.7	Pt
	4478.5	9.6	B			
203226 V VULPECULAE—						
	4495.6	9.0	Pt			
203429 R MICROSCOPII—						
	4426.9	12.0	Bl	4448.0	9.9	Bl
203611 Y DELPHINI—						
	4478.5	10.4	B	4495.6	11.8	Pt
	4488.4	11.0	B			
203816 S DELPHINI—						
	4478.3	8.8	B	4498.6	8.7	Hu
	4495.6	8.9	Pt			
203847 V CYGNI—						
	4461.2	11.7	Ch	4478.5	9.7	B
	4473.2	11.4	Ch	4495.6	8.9	Pt
	4476.6	10.9	Wf			
203905 Y AQUARII—						
	4389.7	9.7	Cy	4462.1	10.5	Ch
	4402.7	9.4	Cy			
204016 T DELPHINI—						
	4387.7	9 8	Cy	4472.5	13.6	B
	4397.7	10.2	Cy	4489.5	13.5	B
204102 V AQUARII—						
	4462.1	8.5	Ch	4495.6	8.1	Pt
	4472.1	8.0	Ch			
204104 W AQUARII—						
	4475.3	[13.5	L			
204215 U CAPRICORNI—						
	4472.4	13.5	B	4489.4	12.0	B
204318 V DELPHINI—						
	4472.5	[12 7	B	4497.5	[12.6	B
204405 T AQUARII—						
	4389.7	7.4	Cy	4468.1	11.5	Ch
	4462.1	11.3	Ch	4495.6	13.6	Pt
204846 RZ CYGNI—						
	4472.5	13.6	B	4490.5	13.6	B
	4476.6	13.6	Ie	4495.6	13.6	Pt
204954 S INDI—						
	4448.0	[13.5	Bl			
205017 X DELPHINI—						
	4476.5	12.8	B	4495.6	14.0	Pt
	4490.4	13.2	B			
205923a R VULPECULAE—						
	4462.1	10.3	Ch	4480.5	10.7	B
	4475.6	11.0	Wf	4481.6	11.0	Wf
	4476.6	11.2	Wf	4495.6	11 2	Pt
	4480.6	11.0	Wf	4498.6	10.5	Hu
210124 V CAPRICORNI—						
	4426.9	10.6	Bl	4448.0	11.7	Bl
210129 TW CYGNI—						
	4478.5	10.2	B	4488.4	10.6	B
210221 X CAPRICORNI—						
	4448.0	[12.7	Bl			
210382 X CEPHEI—						
	4499.5	13 3	B			
210504 RS AQUARII—						
	4472.5	13.6	B	4489.4	13.4	B
210516 Z CAPRICORNI—						
	4472.5	13.7	B			
210812 R AQUILAE—						
	4389.7	12.6	Cy	4488.4	11.0	B
	4402.7	11.4	Cy	4495.6	11.5	Cy
	4465.7	10.0	Cy	4495.6	11.5	Pt
	4478.5	10.7	B	4499.5	11.7	B
210868 T CEPHEI—						
	4369.0	6.0	Ik	4459.1	8.7	Ik
	4371.0	6.1	Ik	4459.3	8.8	Kb
	4374.0	6.1	Ik	4459.9	8.7	Ik
	4375.0	6.3	Ik	4460.9	8.8	Ik
	4382.0	6.4	Ik	4461.9	8.8	Ik
	4384.0	6.5	Ik	4463.9	8.8	Ik
	4386.0	8.5	Ik	4466.3	9.0	Kb
	4387.0	6.0	Ik	4468.0	8.8	Ik
	4389.7	6.6	Cy	4468.1	9.0	Ch
	4390.0	6.9	Ik	4468.9	8.8	Ik
	4391.0	6.9	Ik	4469.3	9.3	Kb
	4443.9	8.6	Ik	4470.1	8.8	Ik
	4444.9	8.6	Ik	4470.2	8.6	L
	4446.0	8.7	Ik	4470.3	9.4	Kb
	4446.9	8.7	Ik	4471.1	8 9	Ik
	4447.9	6.7	Ik	4473.3	9.5	Kb
	4448.3	8.6	Kb	4474.6	9.3	Jo
	4448.9	8.6	Ik	4476.6	9.1	Du
	4449.3	8.6	Kb	4477.2	9 5	Ch
	4449.9	8.6	Ik	4480.5	9.1	B
	4450.9	8.6	Ik	4484.5	8.9	L
	4452.1	8.6	Ik	4495.6	9.0	Pt
	4452.3	8.6	Kb	4496.6	8 8	Jo
	4457.9	8.7	Ik	4500.6	9.1	Jo
210903 RR AQUARII—						
	4389.7	9.1	Cy	4489.4	13.9	B
	4478.5	13.6	B	4495.6	13.4	Pt
211614 X PEGASI—						
	4389.7	9.3	Cy	4495.6	11.9	Pt
	4395.6	11.9	Cy			
211615 T CAPRICORNI—						
	4426.9	9.0	Bl	4468.0	11.5	Ch
	4448.0	10.0	Bl	4478.5	11.9	B
212030 S MICROSCOPII—						
	4448.0	12.0	Bl			
212814 Y CAPRICORNI—						
	4472.5	[13.5	B			
213244 W CYGNI—						
	4460.0	6 5	Kd	4476.0	6.6	Kd
	4461.9	6.6	Kd	4481.9	6.6	Kd
	4469.0	6.6	Kd			
213678 S CEPHEI—						
	4388.7	8.7	Cy	4485.6	9.8	Cy
	4403.7	8.8	Cy	4494.5	9.8	Lp
	4464.7	9.4	Cy	4495.6	8 6	Pt
	4476.8	9.2	Cy	4498.6	8.6	Hu
	4480.5	9.0	B			
213753 RU CYGNI—						
	4389.6	8.5	Cy	4476.6	9.9	Cy
	4361.2	9.8	Ch	4493.7	9.8	Cy
	4464.7	10 0	Cy	4495.6	9.4	Pt
	4470.2	9.8	Ch			
213843 SS CYGNI—						
	4384.6	11.1	Cy	4475.6	9.8	Wf
	4384.6	11.3	Bz	4475.6	9.9	Pt

VARIABLE STAR OBSERVATIONS RECEIVED DURING DECEMBER, 1925—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
213843 SS CYGNI—Continued.						
	4387.6	9.8	Cy	4476.1	9.7	Ch
	4388 6	9.5	Cy	4476.2	10.1	Kl
	4389.6	9.4	Cy	4476.4	10.5	Cy
	4390.6	8.7	Cy	4476.5	10.2	B
	4391.7	8.5	Cy	4476.5	10.2	Ie
	4392.6	8.3	Cy	4476.6	10.2	Wf
	4393.6	8.3	Cy	4476 6	10.2	Du
	4394.6	8.3	Cy	4476.6	10.1	Pt
	4395.6	8.3	Cy	4476.6	10.0	Ly
	4396.6	8.3	Cy	4477.2	10.0	Ch
	4397.6	8.3	Cy	4477.5	11.1	B
	4398 6	8.3	Cy	4477.6	10.6	Du
	4401.6	9.0	Cy	4478.2	10.5	Ch
	4402.6	9.5	Cy	4478.5	11.1	Ie
	4403.7	9.6	Cy	4478.5	10.7	Du
	4405.3	10.3	Kl	4478.5	11.2	B
	4407.4	11.1	Kl	4478 6	11.6	Cy
	4411.3	11.3	Kl	4479.2	[10.9	Ch
	4444.6	12.0	Cy	4479.5	11.5	B
	4446.7	12.0	Cy	4480.5	11.6	B
	4452.2	11.7	Ch	4480.5	11 8	Pt
	4453.2	[10.9	Ch	4480.6	11.8	Wf
	4454.2	[11.2	Ch	4481.5	11.8	B
	4456.2	[11.3	Ch	4481.6	11.9	Wf
	4457.2	[10.9	Ch	4483.5	11.7	B
	4458.2	11.6	L	4484.4	12.2	L
	4459.1	12.0	Ch	4485.2	12.2	L
	4460.1	[11.3	Ch	4487.5	11.6	Pt
	4461.2	12.0	Ch	4488.5	11 9	B
	4462.1	12.0	Ch	4489.5	11.9	B
	4463.3	12.2	L	4489.6	11.7	Pt
	4464.1	12.1	Ch	4490.7	10.9	Gs
	4464.7	12 0	Cy	4491.5	11.9	Ie
	4465.7	11.8	Cy	4491.6	12.0	Du
	4467.2	11.9	Ch	4492.5	11.7	Ie
	4468.1	11.6	Ch	4493.6	11.8	Cy
	4468.4	11.3	Cy	4494.5	11.8	Pt
	4469.1	9.1	Ch	4494.6	[11.3	Ly
	4470.1	8.6	Ch	4495.6	11.7	Pt
	4470.2	8.8	L	4495.6	11.7	Cy
	4471.2	8 6	Ch	4496.4	11.7	Cy
	4471.4	8.7	L	4497.7	[10.0	Gs
	4472.1	8.7	Ch	4498.5	12.0	Ie
	4472.2	8.9	L	4498.6	12.0	Hu
	4472.5	9.0	B	4499.5	11 8	Pt
	4473.2	8.9	Ch	4499.5	11.9	B
	4473.3	9.6	Kl	4499.6	11.8	Cy
	4473.5	9.1	B	4500.5	12.0	Cu
	4473.7	9 4	Gb	4502.4	11.9	Cu
	4474.2	9.2	Ch	4502.5	11.8	Pt
	4474.6	9.6	Bx	4502.5	11.9	Ie
	4474.7	9.5	Gs	4503.5	11.8	Pt
	4475.2	9.5	Ch	4504.4	11 9	Cu
	4475.3	9.9	L			
213937 RV CYGNI—						
	4480.5	7.6	B	4498.6	7.2	Hu
	4495.6	6.6	Pt			
214024 RR PEGASI—						
	4480.5	10.8	B	4495.6	11.7	Cy
	4495.6	11 8	Pt			
214247 R GRUIS—						
	4448.0	10.6	Bl			
215605 V PEGASI—						
	4495.6	11.7	Cy	4495.6	11.5	Pt
215717 U AQUARII—						
	4472.5	12.4	B	4495.6	13.0	Pt
	4489.4	12.5	B			
215934 RT PEGASI—						
	4478.6	11.8	Lv	4495.6	11.9	Pt
	4481.5	11 2	B			
220133a RY PEGASI—						
	4495.6	12.4	B	4495.6	12.0	Pt
220133b RZ PEGASI—						
	4495.6	12.9	B	4495.6	12.7	Pt
220412 T PEGASI—						
	4467.2	[11.6	Ch	4499.5	13.6	B
220714 RS PEGASI—						
	4495.6	9.4	Pt			
222129 RV PEGASI—						
	4476.5	11.2	B	4489.5	11.0	B
222439 S LACERTAE—						
	4476.5	12.2	B	4495.6	12.4	Pt
	4478.6	12.6	Lv	4495.7	12.2	Cy
	4495.6	13.1	B	4499.5	13.0	B
222867 R INDI—						
	4448.0	12.0	Bl			
223841 R LACERTAE—						
	4467.2	10.6	Ch	4495.6	12.1	Pt
	4474.6	11.0	Lv			
225120 S AQUARII—						
	4499.5	10.0	B			
225914 RW PEGASI—						
	4478.5	12.2	B	4499.5	13.5	B
	4495.6	13.4	B			
230110 R PEGASI—						
	4405.3	10.3	Kl	4432.3	11.0	Kl
	4410.4	10.4	Kl	4495.6	12 8	Pt
	4415.3	10.4	Kl			
230759 V CASSIOPEIAE—						
	4387.6	11.0	Cy	4478.5	8.5	B
	4392.6	10.7	Cy	4495.6	8.9	Pt
	4403.7	9.6	Cy	4495.7	9.3	Cy
	4464 7	8.1	Cy	4499.6	9.5	Cy
	4476.7	9.0	Cy			
231425 W PEGASI—						
	4405.3	9.4	Kl	4467.2	8.2	Ch
	4407.4	9.2	Kl	4472.2	8.3	Kl
	4410.4	9.3	Kl	4473.3	8.8	Kl
	4414.4	9.3	Kl	4474.6	8 4	Lv
	4422.4	8.8	Kl	4476.2	8.6	Kl
	4424.3	9.0	Kl	4481.2	8.7	Kl
	4429.2	8.9	Kl	4491.6	8.4	Jo
	4431.3	8.7	Kl	4493 2	8.8	Kl
	4433 3	8.7	Kl	4495.7	9.1	Cy
	4466.2	8.2	Kl	4500.6	8.2	Jo
231508 S PEGASI—						
	4467.2	8.2	Ch	4495.6	8.1	Pt
	4476.7	8.5	Cy	4495.7	8.4	Cy
232848 Z ANDROMEDAE—						
	4467.3	10.0	Ch	4495.7	10.5	Cy
	4495.6	9.8	Pt	4500.5	10.2	Cu

VARIABLE STAR OBSERVATIONS RECEIVED DURING DECEMBER, 1925—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
233335 ST ANDROMEDAE—						
	4467.3	9.3	Ch	4495.6	8.8	Pt
	4479.5	9.0	B	4498.6	9.0	Hu
233815 R AQUARII—						
	4461.2	9.6	Ch	4495.6	10.6	Pt
	4468.1	9.9	Ch			
233956 Z CASSIOPEIAE—						
	4464.7	11.7	Cy	4478.6	11.0	Lv
	4476.7	11.3	Cy	4481.5	10.7	B
	4477.5	10.7	B	4489.5	10.5	B
	4478.5	10.9	Ie	4495.7	11.0	Cy
235053 RR CASSIOPEIAE—						
	4472.5	13.4	B	4490.5	13.0	B
235209 V CETI—						
	4448.0	9.4	Bl	4484.4	10.0	L
235209 V CETI—Continued.						
	4463.4	9.4	L	4495.6	10.4	Pt
	4471.4	9.7	L			
235350 R CASSIOPEIAE—						
	4387.7	9.4	Cy	4478.7	12.1	Cy
	4464.7	11.9	Cy	4480.5	11.2	B
	4467.3	11.5	Ch	4495.7	12.0	Cy
	4478.6	11.7	Lv			
235525 Z PEGASI—						
	4476.7	8.3	Cy	4495.6	8.6	Pt
235855 Y CASSIOPEIAE—						
	4479.5	12.6	B	4495.6	13.0	B
235939 SV ANDROMEDAE—						
	4474.6	12.0	Lv	4492.6	10.9	Ie
	4477.5	11.7	B	4495.6	10.2	Pt
	4489.5	10.7	B			

Total observations, 1566; stars observed, 334; total observers, 26.

The following observers have contributed to this report: Allen, "Al"; Baldwin, "Bl"; Barnes, "Bx"; Berman, "Bi"; Bouton, "B"; Brotzman, "Bz"; Chandra, "Ch"; Cilley, "Cy"; Cunningham, "Cu"; Dunham, "Du"; Gaebler, "Gb"; Goodsell, "Gs"; Hunter, "Hu"; Iedema, "Ie"; Ikeda, "Ik"; Jones, "Jo"; Kanda, "Kd"; Koelbloed, "Kb"; Kohl, "Kl"; Lacchini, "L"; Leavenworth, "Lv"; Lepper, "Lp"; Mrs. Lytle, "Ly"; Peltier, "Pt"; Petrie, "Pj"; Waterfield, "Wf".

LEON CAMPBELL, Recording Secretary.

January 9, 1926.

COMET NOTES.

Tuttle's Comet Rediscovered.—Tuttle's periodic comet was observed by Baade at Bergedorf on the evening of January 12 in the following position:

Universal Time	α 1926.0	δ 1926.0
January 12.7907	$22^h\ 27^m\ 52^s$	$+40°\ 18'$

Its magnitude is given as 15, so that it is not visible with small telescopes.

The position is quite near to that indicated by the first of the two search ephemerides given on page 68 of the January number of POPULAR ASTRONOMY, the correction being about -0^m5 in α and $-12'$ in δ. This will be called comet 1926 *a*.

New Comet 1925 *b* (Blathwayt).—A cablegram from Copenhagen to Harvard College Observatory announced the discovery of a new comet of the eleventh magnitude by Blathwayt. Its position was observed at Capetown on January 16. The following observations have come to hand:

OBSERVATIONS OF COMET 1926 *b* (BLATHWAYT).

Universal Time	α h m s	δ ° ′ ″	Observer	Place
Jan. 16.9248	12 12 14.5	—30 11 23	Innes	Capetown
20.5576	11 53 43.6	—27 01 13	Jeffers	Mt. Hamilton
21.5672	11 47 46.1	—25 55 36	Jeffers	Mt. Hamilton

The comet when found was in Hydra just below Corvus, the Raven, and is moving northwest through Crater and Sextans toward the head of Hydra. The motion is rapid, about 2° per day. The magnitude on January 21 was given as 10.

Comet 1925 *l* (Ensor). — As we suggested might be possible in our comet notes in the last issue, this comet is rapidly coming north. The preliminary elements indicate that it will cross the equator about February 21, but will then be setting about an hour after the sun and so will not be in favorable position for observation. It is approaching the sun rapidly and at perihelion, about Feb. 12, will be at about Mercury's distance, or less, from the sun. As it had a tail 15′ long when discovered, it may be quite a conspicuous object after perihelion, when it will be passing through the northern sky, in March and April.

The following ephemeris, computed from rough preliminary elements by Dr. A. C. D. Crommelin, given in the B.A.A. Circular No. 17, may be considerably in error, but will serve to give the reader some idea of where to look for the comet. If the ephemeris is correct the comet will be passing through Cygnus to Cassiopeia during March.

Rough Ephemeris of Comet 1925 *l* (Ensor).

0h U. T.		α	δ	Log *r*	Log Δ
		h m	° ′		
1925 Dec.	30	0 37.3	—58 58	0.072	0.022
1926 Jan.	15	22 54.3	—46 12	9.927	0.061
	31	21 53.5	—32 15	9.673	0.093
Feb.	16	21 01.1	— 8 42	9.449	0.046
Mar.	4	21 44.8	+29 21	9.805	9.901
	20	0 55.1	+61 21	9.998	9.956
Apr.	5	0 55.7	+77 50	0.118	0.063

Ephemeris of Peltier's Comet.—Mr. F. E. Seagrave sends the following ephemeris of Peltier's comet, computed by him from elements recently published by Dr. A. C. D. Crommelin, of the Royal Observatory, Greenwich, England. During February and March the comet will be too far south and too much behind the sun for observation.

Ephemeris of Comet 1925 *k* (Peltier-Wilk).

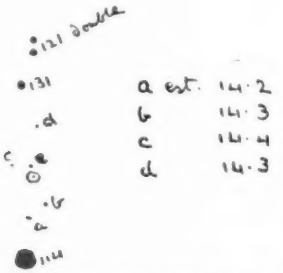
Date 1926		α	δ	Log *r*	Log Δ
		h m s	° ′ ″		
Feb.	15	20 45 40	—30 28 39	0.17013	0.36850
	19	20 47 44	—31 27 30	0.18617	0.37098
	23	20 49 42	—32 27 15	0.20165	0.37246
	27	20 51 32	—33 28 23	0.21657	0.37299
Mar.	3	20 53 13	—34 31 28	0.23095	0.37266
	7	20 54 43	—35 36 49	0.24483	0.37152
	11	20 56 01	—36 44 55	0.25825	0.36963
	15	20 57 04	—37 56 09	0.27121	0.36708
	19	20 57 51	—39 10 58	0.28371	0.36386
	23	20 58 16	—40 29 56	0.29587	0.36016
	27	20 58 20	—41 52 46	0.30755	0.35594

COMMUNICATIONS.

A Note on Some Faint Stars in the Neighborhood of Z Cassiopeiae 233956. — Out of my working list of about ninety variable stars I have for some years considered this as one of the most difficult to observe properly at minimum, both because of its extreme faintness at that stage, and because it then approaches, or even sinks below, several very faint stars in its immediate vicinity which are not shown on the blue print issued by Harvard College Observatory to the members of the AAVSO.

As soon as this was realized, I took steps to make a chart of these faint stars, and as occasion offered have improved it, until it well satisfied my eye

at the telescope, and may be considered good enough, in the absence of micrometer measurements, to enable any observer, with an eye and instrument equal to mine (a 12½-inch reflector) to recognize the field without much possibility of mistake.



FAINT STARS NEAR Z CASSIOPEIAE.

If these stars, *a*, *b*, *c*, and *d*, on the appended chart, had been the only ones, there would have been little need for this description, but lately I have noticed another, *e*, much closer to Z than *c*. There is not very much possibility of mistaking Z for any of the first four stars above mentioned, as the trained observer will soon note the alignment of Z with the two comparison stars 114 and 131, and avoid error, but *e* is a very much more likely source of error. Owing to the proximity of this star, I consider that no telescope of less than 15 or 18 inches can deal satisfactorily with the variable near minimum, and observations made with smaller ones should be viewed with doubt unless it is specially mentioned that both Z and *e* were seen, and in cases like this it is to be regretted that the H. C. O. authorities do not insist on the publication of the actual light comparison of each observation.

In the attached chart no great stress should be laid on the magnitudes assigned to the faint stars. They are the result of several observations, and are based on the H. C. O. comparison star 134, but in my opinion this star is somewhat overrated, and 137 seems nearer the right figure. It is to be hoped that H. C. O. will see their way to publish a large scale chart of this interesting star, and give accurate magnitudes to the faint stars, especially to *c* and *e*.

W. F. H. WATERFIELD.

Nakusp, B. C., September 12, 1925.

Occultation of γ Capricorni Oct. 25, 1925.—The note by Mr. Yalden, on page 622 of the November POPULAR ASTRONOMY, discussing the accuracy of the graphical method of predicting occultations, suggested my own experience along the same line. I used Mr. Rigge's graphic method for the star γ Capricorni, October 25, 1925. To check results I used the *American Ephemeris* formulae. The results follow.

	Graphical Solution	Numerical Solution	Difference
	h m s	h m s	s
Immersion	9 12 36	9 12 48	12
Emersion	10 6 36	10 7 42	66

The large difference in case of emersion was due to the fact that the circle representing the moon's shadow and the eclipse representing the apparent path of place were so nearly tangent that it was hard to find their place of intersection.

Unfortunately clouds made actual observations impossible.

I too can heartily recommend Mr. Rigge's book and would like to say that occultations can be worked out graphically about five times faster than numerically and with much less chance of mistake.

LELAND S. BARNES.

310 S. Vendome St., Los Angeles, Calif., Nov. 18, 1925.

The Aurora of October 23, 1925.—As soon as dusk had fallen on the evening of October 23, the auroral arch became visible in the northern sky. Other than a rather unusual brilliancy, however, there was nothing to differentiate this arch from many others which have appeared recently. No marked activity occurred until about 9:30 P. M., when streamers began to issue forth from the arch and the area immediately beneath commenced to show signs of breaking up into patches and streaks of light. Several vivid areas of pale apple green light started from the horizon and traveled with great speed toward the zenith, fading out as they ascended. At 9:40 P. M. the main arch moved in a westerly direction and increased in brilliancy. At the same time a new and smaller arch began to form in the east.

Within twenty minutes the display had become more spectacular and the sky filled with swiftly moving patches and curtains of light waving to and fro as far as the Milky Way and beyond. Some of the luminous patches moved with almost unbelievable speed while others traveled with aggravating slowness. At times streamers would start simultaneously from the east and west and ascend until they met at the zenith, then gradually fading out.

At 10:10 P. M. the small arch in the east had grown larger and displaced the western one entirely, soon throwing off long thin streamers of the usual variety. The darting patches of light had now entirely disappeared. The streamers traveled at this time for some distance beyond the zenith and the whole arch seemed to tremble and sway. Several fluctuations in brilliancy were observed. The arch proper was about 4° wide and of a very pronounced greenish yellow. The impression of opacity beneath the arch was remarkable. No stars could be seen in this area. By 10:30 P. M. all activity had died down and only the bright arch remained visible in the north.

The evening's display was not over, however, by any means. At 11:20 P. M. activity along the arch was renewed and the shifting areas of light reappeared. In a few moments the arch separated into three parts, the lowest very brilliant and the upper two of successively less luminosity. The space between each one was about 3°. Traces of a fourth and fifth arch could be followed along a broken line. Several short but intensely bright streamers appeared at this time and traveled slowly along the arch from west to east. The darting patches were fainter now and moved less violently. The appearance of a cluster of streamers of great brilliancy under the arch at 11:50 P. M. seemed like a signal for increased activity all along the arch and at 12:00 midnight the five arches were quite plain.

A gradual breaking up of the arches commenced at 12:15 A. M. and soon nothing but nebulous areas and clouds of luminosity were left. No distinct arch was to be seen and the streamers died out. In about ten minutes the curtain form of display became more prominent than at any previous time during the evening and kept up until 12:45 A. M. After this the light grew fainter and the activity greatly dimmed. At 1:15 A. M. the arch had reformed low in the north and the whole phenomenon had greatly decreased in volume. Complete cessation of the display did not occur, however, until after 3:30 A. M. Photography of both the arch and streamers was attempted but the results are not known at this writing.

The appearance of two meteors during the display enhanced the brilliancy of the spectacle.

The next morning (October 24) the sun was examined and eight spots counted with a small telescope, one of which was very large. This is the best aurora seen here since March 24, 1923, and that one only lasted until 11:00 P. M.

LEWIS J. BOSS.

Seagrave Observatory, October 24, 1925.

Seven Large Meteorites.—On November 15, at about 10:45 A. M., seven large meteorites were seen to fall in this locality within a radius of something less than ten miles from this city, by seven different parties. Their distribution was such that no two of them could have seen the same meteorite. I have the names of six of these parties, and their statements in regard to their apparent size, their velocity, and direction of motion, I believe are reliable, as they are all personal friends of mine. In four of these cases the observer has guided me to the exact spot where he, or they, stood when the "fire ball" appeared. He then told of its apparent size, mostly about the size of his head, pointed out the direction it seemed to take, judging from trees and buildings, and the point of disappearance, which in every case, was not far from the ground. Trees were marked to establish these lines of direction, and it is hoped that an organized search may be inaugurated with a fair prospect of finding one or all. The seventh one was reported in a local paper to have been observed, and subsequently found, near the village of Milford about twelve miles from here. The general direction of all of these was northerly, varying a little to the east or west of north. As the constellation of Leo was at that time just past the meridian it seems that they must belong to the Leonids.

GEORGE. I. HOPKINS,
Curator of Manchester Institute of Arts and Sciences.

841 Beech St., Manchester, N. H., Dec. 19, 1925.

GENERAL NOTES

Oscar Lee Dustheimer, professor of astronomy at Baldwin Wallace College, Berea, Ohio, will give a series of Astronomical Talks over WEAR, Cleveland. The following subjects will be broadcast: A Perpetual Calendar; Venus as an Abode of Life; Easter; Habitability of Mars; Biblical Astronomy; and Our Sun and Others. The first of these talks will be given on January 22, at 7:45 P. M. E. S. T.

Mr. John Tatlock, of New York City, died on January 3, 1926, at the age of 66. Although engaged in business, banking and insurance, for the major part of his life, he was greatly interested in astronomy, and was a familiar figure at the meetings of the American Astronomical Society. He was associate astronomer at the University of Wisconsin in 1883-4 and professor of astronomy at Beloit College, Beloit, Wisconsin, in 1884-5. He was a fellow of the Royal Astronomical Society, London, England.

Astronomers Officers of the American Meteorological Society.—It is interesting to note the number of astronomers who are holding office in the American Meteorological Society. Professor W. I. Milham, of Williams College, has been president of the Society for the past two years, Professor A. E.

Douglass, of Arizona University, has been vice president for the same time, and Professor Dinsmore Alter, of the University of Kansas, has just been elected vice president for the coming two years. Professor Milham becomes a member of the council.

The Total Eclipse of January 14, 1926. - No direct reports have come from the observing praties in Sumarta, but from the daily prses reports it would seem that the weather was not very favorable and that the observations of the eclipse were only partially successful.

Dr. E. E. Free, Editor of *The Scientific American*, has kindly sent us a clipping from the *New York Herald-Tribune* of January 15, containing an account of the eclipse by himself, based on the cable messages, and also press reports from Philadelphia, Cambridge, Batavia, Benkoelen, and Palembang. Some of the reports are contradictory, but as nearly as we can determine the weather was partially clear at Benkoelen and the Sproul Observatory party secured good photographs of the solar corona, which was of the "maximum" type. Thin clouds may have made useless the photographs taken to test the Einstein effect.

Harlan T. Stetson cabled to Harvard: "Thin clouds; partially successful."

All the parties at Benkoelen appear to have carried through their entire programs, as planned.

The U. S. Naval Observatory party at Tebing Tinggi was hindered greatly by cloudy weather, carrying out only one-third of its program, with doubtful results.

At Palembang heavy clouds prevented observation of the first phase of the total eclipse by a Dutch astronomical expedition.

No word has been received from the Italian expedition under D'Arturo, near the east coast of Africa.

Annals of the Dearborn Observatory.—Volume II of the Annals of the Dearborn Observatory of Northwestern University, which has just come to hand, is a splendid volume of 219 quarto pages. It contains the results of double star measures made by the director, Philip Fox, during the years 1915 to 1925. The list of stars observed includes all of those which were discovered to be double by S. W. Burnham in the years 1874-1880, as well as a larger number of other pairs which were interesting or required measurement for various reasons.

In the Introduction is given a list of the hypothetical parallaxes of 28 binary pairs. These range from 0".005 to 0".064. There is a list also of 40 stars showing annular proper motions ranging from 0".031 to 2".265, determined from the micrometric measures connecting bright stars with faint stars in the same field of view. The star having the largest proper motion in the list is Σ 2398, a pair, of magnitudes 8.2 and 8.7 respectively, now about 17" apart and exhibiting slow orbital motion.

Seeing Stars by Daylight.—The following clipping from the Birmingham, Alabama, News of July 18 came in recently:

SEEING STARS BY DAYLIGHT.

"I have read that Prof. Charles Clayton Wylie, of the University of Illinois, declares that seeing stars by daylight is a myth," said Howard T. Martin of Marion County, Indiana. "However, if he will come to my home I can convince him of his error. I do not know if the experiment is tried in other communities, but many our farmers in Marion County have the habit of descending to the bottom of their 70-foot silos in the daytime and looking at the stars. This is quite common in early September when the silos are empty, and I myself have plainly seen Ursa Major, Algol and Capella in the early afternoon of a September day."

The reference is to a note in *Science* by Dr. Wylie, formerly of this Observatory. Perhaps someone will be interested enough to try this experiment in agricultural astronomy next September.

ROBERT H. BAKER.

University of Illinois Observatory, December 21, 1925.

Summary of Sun Spot Observations at Mount Holyoke College, 1925.

		North of Equator		South of Equator			
Month	No. of Obs.	No. of Groups	Av. Lat.	No. of Groups	Av. Lat.	Av. No. at one Obs.	New Groups
January	13	1	+24°.3	1	−18°	0.37	2
February	15	6	21.8	4	20.9	1.93	10
March	18	4	19.2	4	27.5	1.28	7
April	20	12	20.2	3	22.3	2.85	15
May	18	8	21.4	8	21.2	3.89	15
June	9	10	22.2	5	21.2	7.67	13
September	10	7	21.2	2	22.5	4.80	9
October	15	8	16.0	9	19.0	3.67	14
November	17	6	23.0	4	22.2	2.59	8
December	18	12	23.8	8	16.1	5.15	20
Total	153	74		48			113

Average number at one observation	3.29
Average latitude of groups north of equator	+21°.42
Average latitude of groups south of equator	−20°.56
Number of days without spots	17

Most of the observations of the first half-year were made by Miss Alice Farnsworth, those of the second by Miss Hazel Burton.

ANNE S. YOUNG.

John Payson Williston Observatory.

The Millikan Rays. — At the meeting of the National Academy of Sciences at Madison, Wisconsin, in November, Prof. R. A. Millikan announced the discovery of a new kind of rays of exceedingly great penetration which were not completely absorbed until they had passed through 68 feet of water, the equivalent of 6 feet of lead. The wave-length of the new rays is by far the shortest known, only about one ten-millionth of the wave-length of ordinary light.

The source of these new rays appears to be in interstellar space and Professor Millikan suggests that their origin may be due to the formation of helium from hydrogen. The discovery of these rays represents a great experimental achievement, which involved work with sounding balloons in Texas at altitudes up to ten miles in 1922, tests with delicate electroscopes at the summit of Pike's Peak in 1923, and, finally the crucial experiments in the waters of Muir Lake at an altitude of nearly 12,000 feet in 1925. Should their suggested origin prove to be correct a new factor will have to be introduced into cosmological theories.

The Spectrum of the Aurora. — The auroral spectrum has been investigated many times but, until recently, the origin of the principal spectral line in the green at λ 5577 has been in doubt. About two years ago Vegard announced that he had succeeded in obtaining this line by bombarding solid nitrogen with a stream of cathode rays. Other investigators, in attempting to repeat Vegard's work, failed to obtain his results. In a recent number of the *Proceedings of the Royal Society*, London, McLennan and Shrumm, of the University of Toronto,

report the results of a series of experiments which appear to solve the auroral spectrum problem. The apparatus used was a long vacuum tube, a 50,000 volt transformer with about 30 amperes at 110 volts passing through the primary winding, and some auxiliary pieces. Upon passing the heavy discharge through the tube containing various gases they were able to demonstrate that the green auroral line is obtained from oxygen. Their experiments may be summarized as follows: The green auroral line cannot be obtained from pure helium nor from nitrogen; it can be obtained very faintly from pure oxygen; a mixture of a small amount of air and large quantities of helium gave the line; a neon and oxygen mixture also gave the line; a mixture of helium, oxygen and nitrogen gave the entire auroral spectrum.

Their theory of the auroral spectrum is that electrons from the sun excite helium in the upper atmosphere either to the metastable state or ionize it. The helium in turn excites the nitrogen and oxygen. The oxygen is responsible for the green auroral line and one other at λ 4368 while the nitrogen is responsible for the remaining auroral lines. From their experiments McLennan and Shrumm also state that a temperature of —73° C is indicated at an elevation of 60 km above the earth's surface.

This indirect proof of the existence of helium at the altitude of the aurora, 50-750 km, in much greater proportions than oxygen is of the greatest importance in the study of the composition of the earth's atmosphere. Theoretical considerations have led investigators to expect lighter gases, such as helium and hydrogen, to be present in relatively large proportions as compared with nitrogen and oxygen at great elevations, but this is the first proof of their existence.

Yale Observatory Transactions. — Volume 4 of the Transactions of the Astronomical Observatory of Yale University, recently published, contains a catalogue of 8359 stars in the zone +50° to +55° of declination, by Frank Schlesinger and Ida Barney. This is a very important contribution to stellar astronomy, not only in that it gives the positions and proper motions of a large number of stars, but in that it gives a practical demonstration of the applicability of photography with a relatively small camera and wide field of view to the rapid determination of star positions "in quantity."

The work presented in this volume constitutes the re-observation by photography of all the stars in the Astronomische Gesellschaft Zone +50° to +55°. The plates used were taken in the interval 1915 August 31 to 1916 July 14. The measures were made mostly in 1916, 1917 and 1922, by Mr. Hudson and Miss Stocker at the Allegheny Observatory and by Miss Booth and Miss Barney at the Yale Observatory.

The aperture of the camera employed was 103 mm, but a diaphragm midway between the second and third lenses cuts down the effective aperture to 75.5 mm, the focal length being 1.635 meters. The resulting scale of the plates was 126″2 to the millimeter. Under normal conditions an exposure of 15 minutes was sufficient to photograph all the Gesellschaft stars except a few of the faint ones that are yellow or red. The plates were usually exposed for 25 minutes in order that all the images to be measured should be fully blackened.

Professor Schlesinger gives full details of the methods employed to secure accuracy in the measurements and reductions. He gives as the probable errors of the mean of two photographic positions ±0″.161 in right ascension and ±0″.156 in declination, which compares very favorably with the best meridian circle determinations.

In an appendix to the volume there are given the positions of 1070 com-

parison stars in the same zone, as determined during the years 1917-18 by Professor R. H. Tucker with the Lick Observatory Meridian Circle. These positions were used in the reduction of the photographs.

Dwarf Star with Variable Bright Lines.— The star Potsdam Astrographic 1214,608, R.A. $20^h\,56^m.3$, Dec. $+39°\,41'$, was observed at the Lick Observatory and announced to be of spectral class Me, the emission lines of hydrogen being very conspicuous (P.A.S.P., **34**, 342, 1922, and L.O.B., **11**, 127, 1923). The apparent magnitude of this object is 9.7, and the parallax measured at the Yerkes Observatory, $0''.081$, giving an absolute magnitude of 9.2.

On plates taken recently with the 24-inch reflector the spectral class is estimated as M2, but no emission lines are visible. Study of the available chart plates shows that the light variation of this star, if any, must be very small.

(W. J. L.)

Harvard College Observatory Bulletin 830.
Cambridge, Massachusetts, December 29, 1925.

Notes on Variable Stars. — In the course of the work with the photoelectric photometer of the University of Illinois Observatory three variable stars were recently detected:

ν *Eridani* (R.A. $4^h\,31^m$, Decl. $-3°\,33'$, Magnitude 4.12, Class B2). This is a Cepheid variable of very short period; its behavior resembles closely that of 12 Lacertae The period of the light fluctuations is apparently quite regular, but the range is variable. Preliminary elements are: Maximum light = 2424465.764 $+0^d.15430$ E. G.M.T. The average range is slightly less than 0.1 magnitude. Henroteau has found short-period oscillations of the lines in the spectrum of this star.

14 *Canum Venaticorum* (R.A. $13^h\,01^m$, Decl. $+36°\,20'$, Magnitude 5.11, Class B9). The range of variation is 0.2 magnitude. Near maximum the fluctuation is very rapid. The period is probably only a few hours. This star will receive further attention here.

γ *Ursae Minoris* (R.A. $15^h\,21^m$, Decl. $+72°\,11'$, Magnitude 3.14, Class A2) or ζ *Ursae Minoris* (R.A. $15^h\,48^m$, Decl. $+78°\,06'$, Magnitude 4.34, Class A2). Five series of differences between these stars were observed in May, 1925. It was the intention to study the variations of Gamma, using Zeta as the comparison star. The differences exhibit an unmistakable variation of the very short period Cepheid type, with a range of 0.1 magnitude. Preliminary elements are: Maximum light = $2424301.78 + 0^d.14335$ E.

The spectroscopic variability of γ was announced by Struve, who assigned to it a period of 0.108449 days. It was studied also by Henroteau who states that his observations appear to verify this period. According to Struve, photoelectric observations by Guthnick and Bottlinger indicate slight variations, of the order of 0.04 magnitude, but in no assignable period.

The Illinois results can not be reconciled with the spectroscopic period; moreover, the variation of 0.1 magnitude and its regularity could scarcely have escaped the Berlin observers. Some suspicion, therefore, falls on ζ. The light curve is markedly asymmetric. If the variation is due to ζ, the rise to maximum occupies less than half the period as in ordinary Cepheid variation. Further observations will be required. In the meantime we appear to have in one of these stars the fourth example of a Cepheid of very short period, of which the others are β Cephei, 12 Lacertae and ν Eridani.

ROBERT H. BAKER.

University of Illinois Observatory, December 21, 1925.